CHEMICAL & METALLURGICAL ENGINEERING

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CHEMICAL & METALLURGICAL ENGINEERING

A consolidation of
ELECTROCHEMICAL & METALLURGICAL INDUSTRY *and* IRON & STEEL MAGAZINE
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Volume 26 — New York, March 29, 1922 — Number 13

Measuring Ideas

"IT IS difficult to measure ideas in terms of specific or ad valorem duties. . . . The dye industry involves more than the mere producing of commodities. . . . This industry is unique and it may require unique forms of protection."

These very significant and highly encouraging statements are almost verbatim remarks by Senator SHORTRIDGE, who has been conducting the hearing regarding activities of the dye industry and of dye importers. The remarks occurred just before the Senator made a preliminary informal report to the Finance Committee of the Senate, which is drafting the tariff bill.

Chemical industry can well take encouragement from these comments. Its case has been forcefully and fairly presented thus far. Criticism of the industry has been vitriolic, but based upon false assumptions and misapprehension. The truth regarding the situation is being most satisfactorily brought out by the proceedings and the truth certainly promises to be helpful to the cause of the industry, as might have been known in advance by anyone who took the pains to find out how meritorious and patriotic has been the effort of those who have labored for the establishment of an organic chemical industry in the United States.

The Price of an American Potash Industry

OUR potash people are petitioning Congress for what they consider a moderate scale of protective duties and we are inclined to think that their demands are not exorbitant. Somehow or other we have been steeped in German propaganda for so long and the idea has become so prevalent that the Creator appointed Germany the custodian of the world's potash that it appears almost irreverent to defend an industry elsewhere than in der Vaterland. That is just what we intend to do, however, for a close study of the facts regarding the American potash industry has convinced us that it is deserving of the sink-or-swim chance which the proposed tariff will afford it. Given this protection for 5 years, it is our firm opinion that the nucleus of a potash industry can be developed that will stand on its own feet and justify its existence in competition with the foreign industry. The crux of the situation lies in the successful development of Searles Lake and the lowering of transportation costs by a water route through the Canal and around to the Atlantic seaboard.

In the first place, just to get it off our chest, we want to admit that the domestic industry has many shortcomings and that many acts of its own have stood in the way of its best development. The producers themselves have been responsible for much of the misinformation about the American potash industry. They have met the propaganda we referred to in our opening sentences with similar propaganda, and we are not prepared to say which has been the worse. Stock-selling schemes, wildcat projects and engineering monstrosities have been too common and have caused many potential friends of the industry to lose faith in its future. Another and in our opinion a most serious handicap has been the lack of unity in the ranks of potash producers. The reason, of course, is that our output has come from a dozen widely different sources, representing so many varying costs of production and so many clashing interests that there could be no single voice to speak for the industry. To be sure, the Potash Producers Association in Washington has met this need to some extent, especially as far as legislative activities are concerned, but it is in the industry's business relations that the lack of unity has been most evident. Negotiations with the grouped buyers of the fertilizer industry and the attempts to meet the organized competition of the German and Alsatian potash syndicates called for unified action, but unfortunately resulted in friction and discord.

The tariff for which the industry is petitioning is the sliding scale of duties contained in the bill which passed the House last summer. Under this arrangement the potash producers claim that they can resume operations and build up their production to a basis on which they can meet foreign competition without further aid from the government. They ask for but a fighting chance to go ahead and, sink or swim, they are willing to abide by the results. Obviously not all the producers can compete, even with the benefit of the duty, but many of the plants can continue in business if they have the assurance that they will receive a fair price for their product. As these plants enlarge operations, they will lower their costs and thus become better prepared to meet the inevitable competition. Expansion in a going concern usually means only a multiplication of present units, with consequent savings not only in construction costs but in distribution of overhead charges.

The brief of the potash producers, which is reviewed in the news pages of this issue, holds a lesson for other of our chemical industries which are suffering from foreign competition and are half-heartedly awaiting the relief promised them by Congress. The devastation in the dye industry, for example, is not so complete as among the potash producers, but it is evident that the same agencies are at work.

But sizing up the problem from the broad national viewpoint, there are certain outstanding facts about the potash situation which we must not forget. The war taught us the value of several key industries, and a surprising proportion of these were our basic chemical industries. Potash proved to be one of those essential commodities the supply of which we suddenly found was lacking from our industrial make-up. Now, by long and

tedious experimenting and costly research, we have developed the makings of a creditable potash industry. If we permit it to thrive in this country, it will mean that in case of another emergency we will have the nucleus around which we can build up an industry to take care of our entire demands. If, on the other hand, we permit the industry to die, we return to the hands of the foreign producers and the price we must pay for our future supply of this essential element will be dictated by the syndicates in Berlin and Paris.

It is scarcely necessary to urge the chemical industries to lend their support to the potash tariff. The price to be paid for this domestic industry is insignificant in comparison with its value to chemistry in America. If our entire chemical independence could but be purchased by the adoption of such moderate rates of duty, we would indeed have cause for rejoicing.

Lowering Costs and Increasing Production Efficiency

THE necessity of lowering production costs is now generally acknowledged if prices are to be such as to encourage sales and meet foreign competition. Unquestionably costs have been lowered by some manufacturers as far as circumstances will permit, with the result that their business is generally in a better condition than the average. But there still are too many plants where the costs have not been reduced as they should be. Many are trying to carry on with the methods established before the war, and made perhaps more inefficient under the pressure of war production. Conditions in such cases are capable of improvement; but those responsible are beset with conflicting advice, and fear that the expenditures necessary to put their plants in condition to compete are beyond their means. Also, sometimes the inertia of old ways is too strong.

What course, then, should be followed by those who must lower costs and are willing to make the attempt? Is there any definite plan that can be used in all cases to attain this end? We think not. But in spite of the general discredit thrown by the panacea peddlers on those who give advice, there is a counsel of common sense which if applied with fair judgment should do much to bring about the desired ends.

The problem should be studied with a view to applying sound principles that have led to efficient results for others, together with such other measures as the special case may require. All preventable waste must be eliminated. Processes must be arranged to flow continuously in the straightest possible line. Sufficient auxiliary equipment must be added to bring the existing machinery of production to its highest efficiency. Steps must be taken to organize so that the inventory of goods in process is at all times at a minimum. Everything possible must be done to heighten the morale of the workers and to keep the labor turnover at the lowest figure obtainable. The burden of management must be lessened by the elimination of all unnecessary employees and the reduction of the product and its process of manufacture to the simplest terms.

These principles form the framework upon which a comprehensive plan of improvement can be hung. Each must study out his own problem. But, taking these principles as a basis of action, if a definite program is formed and put into effect, the result for that plant can scarcely fail to be lower costs and increased production efficiency.

Furniture For Firewood

CONGRESS is making kindling out of our national furniture with a vengeance. This conclusion seems inevitable when we witness the procedure of the House of Representatives Appropriations Committee ruthlessly hacking at the organization of the executive departments. One of the latest evidences to confirm this idea is the cut which was made in the appropriation for the U. S. Geological Survey. In this case, not content with cutting off the increases which even the hard-headed business men of the budget bureau had approved, the committee slashes still further and makes actual decreases below current funds in several important items for the support of geologic and engineering work.

It takes years to build up a smoothly working efficient scientific organization of any sort in a field of complicated endeavor in research or exploration. In this respect the U. S. Geological Survey is no exception. Its high standing and high standards of performance are the result of years of development and training of its personnel. To cut down such an organization below its pitifully inadequate strength of this year is worse than foolish. It is nationally and economically criminal.

We suggest that our national legislators chop wood on an appropriate woodpile and not hack up the national scientific furnishings of the government in this fashion.

Is It "Exportable Surplus"?

THERE has been a general tendency during recent months to assume that the ammonium sulphate produced in the United States which does not find ready market here is exportable surplus. On the basis of this assumption, Mr. MACDOWELL, president of the National Fertilizer Association, recently estimated that 150,000 to 200,000 tons of ammonium sulphate is produced which will not find market in the United States. He, therefore, has characterized this as a "normal exportable surplus."

It is a demonstrated fact that fertilization of even relatively new soils is a paying proposition. Improvement in economic conditions of the country demands such fertilization. Moreover, the farmer is beginning to realize these facts, and one is not unduly optimistic in assuming that the use of fertilizers is going to increase rapidly in the next few years, even to the extent of doubling the demand within 5 or 10 years. Of course the pace at which increase will come will be determined more largely by economic conditions—that is, the ability of the farmer to buy—than by any other factor. However, it seems likely that this increase in demand will outstrip the increase in production of ammonium sulphate from existing agencies, even though the metallurgical industries demand coke production up practically to the capacity of the coke ovens of the country and thereby increase materially the byproduct ammonia output. The increase in use of fertilizers may therefore be more than enough to absorb all of what we now call "exportable surplus."

There will be continuous readjustment of the relationships of nitrogen production and nitrogen utilization during the coming years. Even a resumption of active purchasing by farmers, a normal operation of metallurgical coke plants for byproduct ammonia output, and the settlement of the question of Muscle Shoals, large as that question now looms on our political horizon,

will not decide the whole situation. The readjustment of relationships will be largely affected also by the new technology of nitrogen fixation, now a demonstrated commercial success. Any interest in the nitrogen industries which neglects this factor, or fails to take account of the latest technology in its own branch of the business, is doomed to disappointment. The country will demand, and undoubtedly will have the benefit of, the best in technology for production of fixed nitrogen at a minimum cost; and moreover the country will see to it that the use of fixed nitrogen in agriculture is extended to the point of maximum efficiency. The laggard in technical affairs is the one who will suffer.

The Annual Report of The Steel Corporation

AS THE United States Steel Corporation reports its earnings quarterly, the 1921 profits have been known for a couple of months, but the annual report, which has just been issued, offers a better opportunity for their study. After allowance for federal income and all other taxes, subsidiary company depreciation charges and general administrative expenses, but before payment of either subsidiary company or Steel Corporation bond interest, the corporation's total earnings amounted to $100,791,279 in 1921, as against $185,095,359 in 1920. The shipments of rolled steel, etc., decreased 43.5 per cent in tonnage, and realized prices decreased greatly, while the reported earnings decreased 45.6 per cent.

This decrease in earnings by comparison with reports made by the majority of independent steel companies is considerably less than would be expected. In some quarters the impression has grown up that "the independents" are at a great "disadvantage" as compared with the Steel Corporation, this alleged disparity accounting for the Steel Corporation reporting earnings while most of the independents report losses. That impression is incorrect. There are several ways by which this can be shown. Perhaps the most interesting is to note that in 1912 and 1913, years in which the Steel Corporation and the independents alike had satisfactory profits, the Steel Corporation's earnings were about $10 per ton of steel shipped. If the typical independent was at a disadvantage as compared with the corporation, the disadvantage could have been no more than a very few dollars a ton. The same number of dollars per ton would not account for the disparities shown in 1921 earnings, while of course there has been no great change since 1912 in the relative positions, as to manufacturing processes used or character of physical equipment.

The divergences are due almost wholly to two things —to a difference in accounting methods and to the Steel Corporation having acquired certain good will in 1920 by holding down its prices, whereby it operated to better advantage in 1921 than did the majority of the independents.

As to accounting methods, it may be remarked that if the Steel Corporation desired the general public to be in ignorance of its financial affairs, as used to be the case with nearly all large corporations, its practice of publishing a full report annually would be a noteworthy application of practical psychology. The Steel Corporation reports are studied by only a very few. As to difference in accounting methods, many corporations, whether in the steel business or not, considered their profits for several high price years, through 1920, as real profits, and in 1921 they were forced to make extensive inventory readjustments, whereby the profits of the good years were left unduly swelled and the profits of a lean year were diminished, sometimes beyond the vanishing point. The Steel Corporation's reserves against inventory were as follows at the ends of the years named:

1916.....	$13,524,794	1919.....	$90,000,000
1917.....	30,270,670	1920.....	95,000,000
1918.....	51,289,603	1921.....	60,710,255

This reserve is of course a continuous fund, rising or falling. When it rose, the corporation was refraining from declaring profits the existence of which it doubted. When the reserve fell $34,000,000 in 1921 this did not represent a padding of profits. The actual profits were simply permitted to stand. If inventory values had never fallen, after Dec. 31, 1920, the corporation would have been forced some day to declare that in the past it had earned $95,000,000 more than it thought it was earning. As it is, the corporation does not need to report that it made any such mistake.

The Mental "Feel" Of the Nature of Matter

ON ANOTHER page of this issue a member of our staff presents a digest of some current thought about the structure of atoms and their occasional isotopes. As in an earlier exposition of the Langmuir postulates, Dr. HENDRICK has not attempted to depict the intricacies of the heavier elements. They are still in that realm of supercomplexity for which the art of exposition seems not yet developed. Even in considering the elementary details there are dicta which seem likely to need an appetizer for the processes of mental digestion, such as the decrease in the weight of protons by a "packing effect" and the nature of the mass of electrons.

In a late number of our excellent contemporary *The Chemical Age* of London (vol. 6, p. 136, Jan. 21, 1922), Dr. STEPHEN MIALL in his "Notes on Some Recent Chemical Theories" says:

> It is not clear . . . why iron, with eight external electrons, should be chemically active while argon and xenon, with eight external electrons, should be inert. LANGMUIR has put forward an ingenious theorem to account for this and some other anomalies, but I will not try to explain it here. When I read his own words I think I understand and I accept his hypothesis, but when I try to put it into plain language I am not sure whether I understand it at all. It may be that future researches will make it easier for us ordinary people to grasp the difficult features, and until then the only way to cover up our lack of intelligence is to assume that we and our readers understand it and that we could put it into simple language if we took the trouble. The Athanasian Creed requires intellect with a similar attitude.

Our author calls a halt somewhat earlier in the game than does Dr. MIALL. He knows that we are strictly undenominational in religion, so that creeds are forbidden subjects, while as for the structure of atoms and isotopes of the higher atomic numbers, he declares he would need weeks of work by LEFFERT LEFFERTS in the preparation of his illuminating atomic models and then many hours of patient instruction from Dr. LANGMUIR himself.

What the author has tried to set forth in the present essay is something to give old chemists and engineers who have not followed the modern literature of physical chemistry the feel of the thing in their minds.

Readers' Views and Comments

Utility of Recrystallization Studies

To the Editor of Chemical & Metallurgical Engineering

SIR:—Referring to the very interesting paper by Jeffries and Archer on "Grain Growth and Recrystallization in Metals" and particularly to the diagrams showing the effect of annealing on grain size of cold-worked material,[1] I wish to call attention to the fact that it is very useful to show such "recrystallization diagrams" in three dimensions: One to express the percentage of deformation in previous cold work, the second to show annealing temperatures and the third to show grain size.

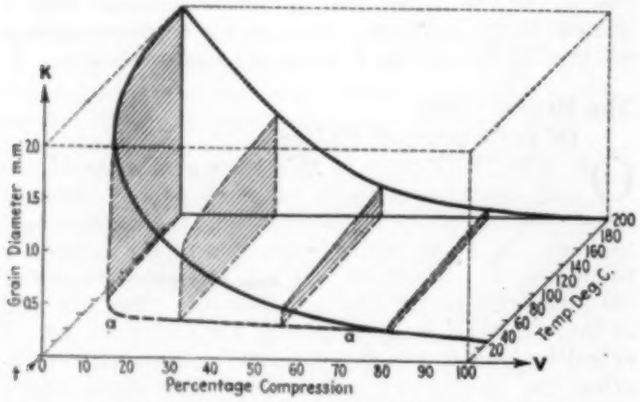

FIG. 1—RECRYSTALLIZATION DIAGRAM FOR TIN, ACCORDING TO CZOCHRALSKI, 1916

This form of diagram, worked out for tin by Czochralski,[2] is shown in Fig. 1.

In this diagram the principal horizontal axis represents the degree of cold work which the material has undergone (for instance, the percentage of reduction of height of a cylinder under compression), the secondary horizontal axis represents the temperature to which the sample was then heated, while the ordinate is the diameter of the grain after recrystallization. If the sample is reheated to a temperature below the curve *a-a*, no change in the grain size takes place.

[1] CHEM. & MET. ENG., March 1, 1922, vol. 26, pp. 405-408.

[2] Czochralski, Grundprinzipien der technologischen Kornverfeinerung; Forschungsarbeiten auf dem Gebiete des Ingenieurwesens, August, 1919.

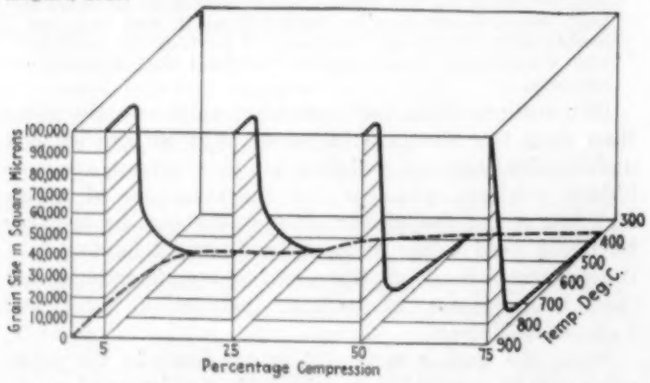

FIG. 2—RECRYSTALLIZATION DIAGRAM FOR ELECTROLYTIC IRON, ACCORDING TO OBERHOFFER AND OERTEL, 1919

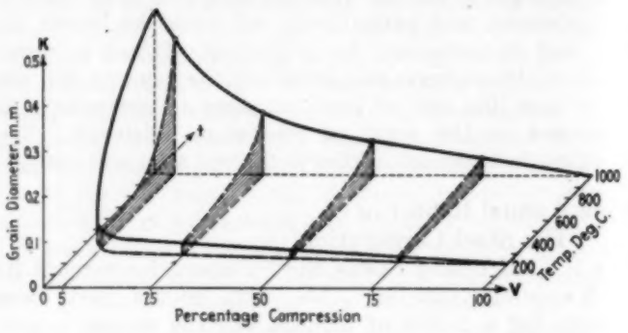

FIG. 3—RECRYSTALLIZATION DIAGRAM FOR COPPER, ACCORDING TO RASSOW AND VELDE, 1920

Above this lower temperature limit, however, the grain soon acquires the average size indicated. As will be seen from the other diagrams, the "body" of the diagram always flattens out with increased degree of cold work—i.e., the grain size of cold-worked metal increases with increasing the recrystallization temperature, but decreases with the degree of cold work.

The phenomena and laws of recrystallization will be of increasing importance to metallurgical investigation, and they are also bound to be of great practical value to future workers.

After the recrystallization diagram of a metal or alloy is once worked out, it is possible to determine the degree of cold work a material had previously undergone, by heating it to a certain temperature and measuring the grain size. The diagram will then reveal the desired information. In a similar way the grain size can

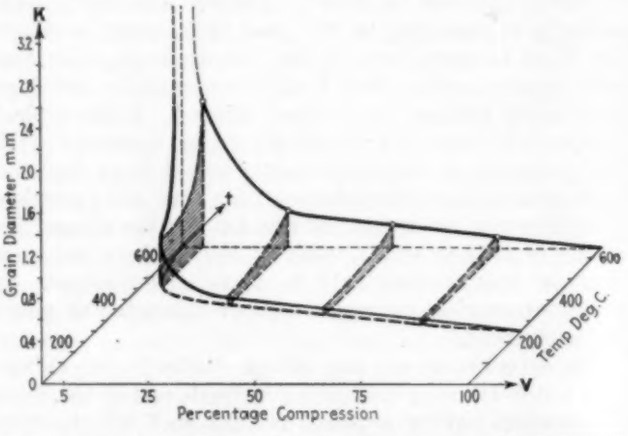

FIG. 4—RECRYSTALLIZATION DIAGRAM FOR COMPRESSED ALUMINUM (98.5 PER CENT), ACCORDING TO RASSOW AND VELDE, 1921

be utilized as criterion of the temperature at which cold-worked metal has been annealed. To do this, the metal is subjected to increasing temperatures until the grain size increases. This temperature must necessarily be higher than the previous annealing temperature. By measuring the grain size produced by the final treatment we can find from the diagram the degree of cold working, and by considering the grain size of the material as delivered we can then ascertain the original

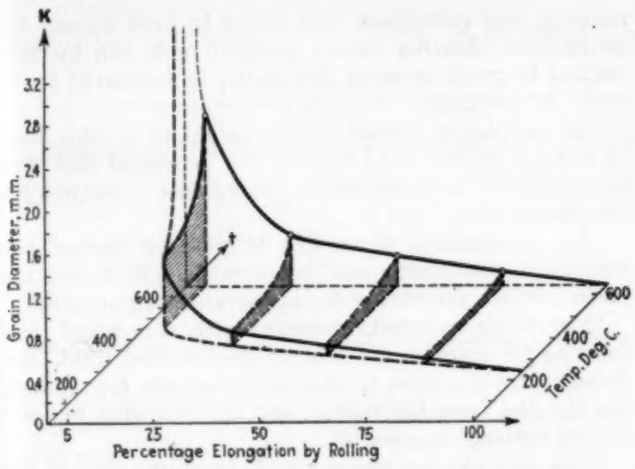

FIG. 5—RECRYSTALLIZATION DIAGRAM FOR ROLLED ALUMINUM (98.5 PER CENT), ACCORDING TO RASSOW, 1921

annealing temperature. By choosing a suitable degree of cold work and a suitable anneal we would be able to produce any desired grain size—in other words, we are enabled to put the metal systematically into a definite physical and mechanical state.

The practical application of these important theoretical considerations is limited mainly by the small number of such recrystallization diagrams which have been worked out so far. As far as I know, they have been published only for tin (Fig. 1), electrolytic iron (Fig. 2), copper (Fig. 3) and aluminum (Figs. 4 and 5). The difference between Figs. 4 and 5, although small, shows that it is advisable to control the manner in which deformation by cold work was produced.

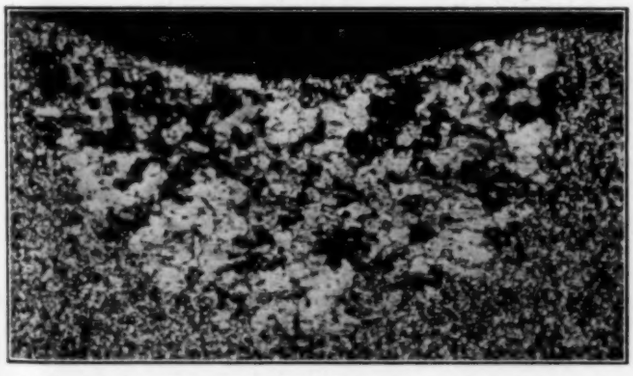

FIG. 6—BRINELL TEST, STATIC LOAD; ANNEALED AT 750 DEG. C. × 15

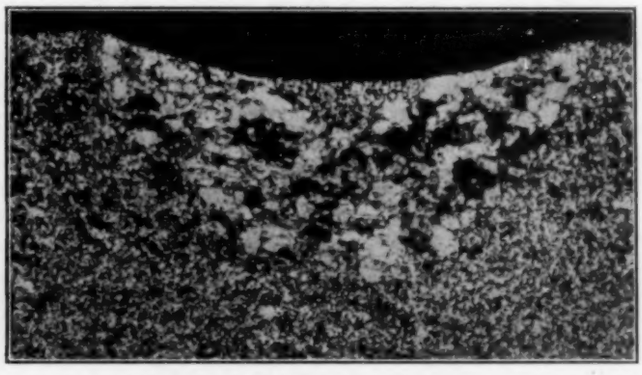

FIG. 7—SAME IMPRESSION AS IN FIG. 6, PRODUCED BY IMPACT; ANNEALED AT 750 DEG. C. × 15

The recrystallization diagram of iron differs from that of tin in one point: Heavy cold work does not increase the grain size with increasing annealing temperature first quickly and then slowly, but in opposite manner.[3]

It will be extremely valuable, both from a scientific and technical point of view, to have such recrystallization diagrams carefully worked out for the most important metals and alloys, especially for those used to a large extent in the industries. Further development along this line will help make the science of metallography available for "quantitative" work, a movement which was originated years ago by Dr. Jeffries and for which much credit is due.

Furthermore, recrystallization studies can doubtless be applied to advantage when investigating strains produced in specimens that have undergone tensile, bending and other mechanical tests. Or, in the diagnosis of failures, recrystallization upon annealing will give the clue as to whether fracture was due to the application of excessive static forces, impact or to faults in chemical composition. For instance, in a recent investigation of the comparative resistance of metals to ball indentations under static and kinetic forces, Wüst and Bardenheuer[4] utilized the recrystallization of strained metal to excellent advantage. They produced ball impressions of equal depth in low-carbon steel by static pressure and by impact; the specimens were then annealed for 1 hour at 750 deg. C. In this way recrystallization was obtained in that zone of the metal in which the cold work had reached a critical degree. Fig. 6 shows a static ball impression (Brinell), while Fig. 7 represents an impression of equal size obtained by impact of a 10-mm. ball.

As will be seen from these illustrations, the zone of coarse grain is much deeper in the impressions produced by static pressure than in those produced by impact.

New York City. HERMAN A. HOLZ.

[3]Oberhoffer, Das schmiedbare Eisen; J. Springer, Berlin, 1920.

[4]Wüst u. Bardenheuer; Härteprüfung durch die Kugelfallprobe; Mitt. a.d. Kaiser Wilhelm Inst. für Eisenforschung, 1920.

Relation Between the Composition of Vapor and Liquor in Distillation

To the Editor of Chemical & Metallurgical Engineering

Sir:—In the number of your paper dated Feb. 15, 1922, there appears an article by Emil Piron on the fundamental laws of distillation. This article is open to serious criticism.

All of the material on page 317 except Table I was developed by Lord Rayleigh and published in the *Philosophical Magazine*, series 6, vol. 4 (1902), p. 521. It was later published in another form by W. K. Lewis in the *Journal of Industrial and Engineering Chemistry*, vol. 1, p. 522 (1909). It has also been discussed by me in my recent book on Distillation (McGraw-Hill, 1922).

The first column of page 318 is taught to the students of most universities in their courses in physical chemistry in the third or fourth year, the first part being due to Francis Marie Raoult, professor of chemistry at Grenoble, France, who published it in 1881, and the second to John Dalton in 1808 (Moore's History of Chemistry, McGraw-Hill, 1918).

I have no criticism of the remainder of pages 318 and 319, except that like all empirical relations its value is doubtful. The final material on page 320 will be

found, except for the specific application, in Lewis' article and in my book.

The reason I object to the publication of such an article is because the average young chemist or chemical engineer who has had a hard time mastering such fundamental laws as those of Raoult and Dalton while in college has discarded them as soon as he gets into the industries as being things impracticable for everyday use. And when such an article appears with those laws in perhaps an unfamiliar form and without the originators' names attached, so that they appear to be original with the writer, the former student infers that something new and also impracticable has been evolved, and hastily crosses over to the other side.

If, on the other hand, the writer had referred to the "well-known laws of Raoult and Dalton with which every one is familiar," and to the "fundamental work of Lord Rayleigh, known to all interested in distillation," he would have struck a responsive chord in the young man's mind, and stimulated the idea that perhaps there was something worth while after all in these old laws.

CLARK S. ROBINSON.

Massachusetts Institute of Technology.
Cambridge, Mass.

Transparent Films of Metal

To the Editor of Chemical & Metallurgical Engineering

SIR:—I have noted at the bottom of p. 204 of the article "Colloidal State in Metals and Alloys" a statement about thin films of metal, which at once reminded me of A. E. Outerbridge's experiments, the results of which I saw in part in 1884, which were reported by him to the Franklin Institute on Feb. 27, 1877. Your readers would probably be glad to have the matter summarized from details Mr. Outerbridge will probably be glad to give or refer you to on Transparent Films of Metal. Instead of dissolving gold leaf, as did Faraday, he produced perfect and far thinner films of gold, silver, platinum and copper by electrodeposition and then solution of the metal receiving the deposit. I tried to get a film of iron to look through by deposition on fused AgCl (horn silver) and solution by NH_4OH, but it would not work and I have little chance for such interesting "things that don't pay" at once except in pleasure.

Bristol, Tenn. ASA W. WHITNEY.

To the Editor of Chemical & Metallurgical Engineering

Sir:—I have not had time to hunt up numerous old publications and notes requested by you covering my early investigations on extremely thin films of metal, but a communication dated April 5, 1895 (vol. 34, p. 67) to the American Philosophical Society by the late Patterson Du Bois refers to several early notices of the process and product. I quote:

"*Transparent Gold.*—In the course of a lecture on gold, delivered before the Franklin Institute on Feb. 27, 1877, A. E. Outerbridge, Jr., of the assay department of the Mint in this city, gave an account of some experiments he has made with the view of ascertaining how thin a film of gold was necessary to produce a fine gold color.

"The plan adopted was as follows: From a sheet of copper rolled down to a thickness of 0.005 in. he cut a strip 2½ x 4 in. This strip, containing 20 sq.in. of surface, after being carefully cleaned and burnished, was weighed on a delicate assay balance. Sufficient gold to produce a fine gold color was then deposited on it by means of the battery; the strip was then dried without rubbing, and reweighed, and found to have gained 0.1 grain, thus showing that 1 grain of gold can by this method be made to cover 200 sq.in., as compared to 75 sq.in. by beating.

"By calculation, based on the weight of a cubic inch of pure gold, the thickness of the deposited film was ascertained to be 1/980,400 in., as against 1/369,650 for the beaten film.

"An examination under the microscope showed the film to be continuous and not deposited in spots, the whole surface presenting the appearance of pure gold.

"Not being satisfied, however, with this proof, and desiring to examine the film by transmitted light, Mr. Outerbridge has since tried several methods for separating the film from the copper, and the following one has proved entirely successful.

"The gold plating was removed from one side of the copper strip, and by immersing small pieces in weak nitric acid for several days the copper was entirely dissolved, leaving the films of gold intact, floating on the surface of the liquid. These were collected on strips of glass, to which they adhered on drying, and the image of one of them is here projected on the screen by means of the gas microscope.

"You will observe that it is entirely continuous, of the characteristic bright green color, and very transparent, as is shown by placing this slide of diatoms behind the film. By changing the position of the instrument, and throwing the image of the film on the screen by means of reflected light, as is here done, you will see its true gold color.

"Mr. Outerbridge has continued his experiments, and, by the same processes, has succeeded in producing continuous films, which he determined to be as little as 1/2,798,000 in. thick, or 10,584 times thinner than an ordinary sheet of printing paper, or 60 times less than a single undulation of green light. The weight of gold covering 20 sq.in. is, in this case, 0.035 grain; one grain being sufficient to cover nearly 4 sq.ft. of copper."

In 1876 I furnished transparent gold films on glass for lantern projection to several universities and possess a note from Prof. Eggleston of Columbia dated Feb. 21, 1876, acknowledging receipt of one such specimen.

In one of my papers I referred particularly to Faraday's thin gold films, made by floating beaten gold leaf on a bath of potassium cyanide. I reproduced those, but found that all beaten gold leaf is full of holes and humps, as might be expected; my films were all continuous and of uniform thickness, as shown by their transparencies and faint green tint by transmitted light.

I never attempted to commercialize the patent (No. 198,209, granted Dec. 18, 1877), though I made a lot of gold foil, some thicker than gold leaf, and used these for various purposes.

One of the most interesting to me was a request from Prof. S. P. Langley for a gold strip to make the first "grill" or resistance bridge for an experimental instrument for measuring infinitesimal variations of heat from stars. This he called a "bolometer." I think the gold film or foil was too good a conductor for his purpose and I remember making one, or trying to, of palladium. All this was so long ago that I have forgotten most of it, but we had several talks and I visited him at his observatory outside of Pittsburgh on a spur of the Alleghanies.

Philadelphia, Pa. ALEX. E. OUTERBRIDGE, JR.

Atoms and Isotopes

A Record of Present-Day Conclusions as to the Structure of Atoms or Atomic Architecture and of the Nature of Isotopes, Including a Short Note on the Leading Contributions of Dr. F. W. Aston, Who Is Now Visiting America

BY ELLWOOD HENDRICK, SC.D.
Consulting Editor, CHEMICAL & METALLURGICAL ENGINEERING

SOMEWHAT over a hundred years ago we—that is to say, we chemists of earlier date and personality—were discussing whether John Dalton was philosophically justified in his theory and whether an indivisible atom were possible or not. We were then, however, as we are today, leaders in pragmatism, and we welcomed then, as we do now, any theory that works. In this respect chemists differ from most physicists who have less urge to be practical, and thus occasionally there arise cleavages between them in habits of thought. The author of a text-book on physics, for instance, would hesitate long before presenting his readers with a two-dimensional exposition of the benzene ring. In chemistry we don't mind a little incongruity like that—so long as it works. And while the earlier generations of us continued to discuss the atomic theory in the abstract, we accepted it for the same pragmatic reason that we accept the benzene ring.

DR. PROUT AND HIS IDEA

Between 1815 and 1817 a London physician, Dr. William Prout, ventured the belief that the atomic weights of the different elements were whole numbers and that, hydrogen being 1, all the elements were aggregates of the atoms of primordial hydrogen. "Many tried to reconcile Prout's hypothesis with facts," says J. W. Mellor,[1] "by changing the standard of reference to something equivalent to half an atom of hydrogen, and then to a quarter of an atom of hydrogen. But having once begun to divide the hydrogen atom, there was no limit to the process of subdivision, and the hypothesis could then be made to fit any conceivable set of atomic weights. This tinkering with Prout's hypothesis brought it for a time into disfavor."

Stas of Ghent, a generation and more later, preceded our own Theodore W. Richards in the meticulously exact determination of atomic weights, and he found so many fractions, contradictory to the whole number hypothesis, that he said: "I have arrived at the absolute conviction, the complete certainty, so far as is possible for a human being to attain to certainty in such matters, that the law of Prout is nothing but an illusion, a mere speculation definitely contradicted by experience."

THE FAITH OF DR. RICHARDS

Stas held the floor, and poor Prout was in limbo for many years after his death, languishing in that purgatory of chemistry to which all those are consigned who propound theories which are not accepted. Richards was not so drastic in his conclusions as was Stas. He took up the work where the Belgian left it off, and proceeded to record his findings, despite the fact that they did not seem to lead anywhere or suggest anything but to add more decimals. The writer remembers an evening about a dozen years ago when Dr. Richards was speaking in an informal manner to a meeting of chemists on the work being done in the Harvard laboratory. He said in substance: "Sometimes we are asked why we devote so much time to work that seems dull and that does not lead more directly to discovery. Our answer to that is that we are gleaning facts, which are duly recorded and made available to others. And in so doing we have in mind that what we do may become useful under greater enlightenment than ours. As yet these records are only so many figures, but under the illumination of a greater intelligence, of a master mind, probably with a mathematical background and a great capacity for co-ordination, they may be so arranged as to reveal what is still unknown. We are getting out stones against the time when the master builder shall come to build the temple."

It was something to that effect which he said in the vein of his usual modesty.

CHLORINE'S SHORT CAREER AS AN OXIDE

Now we shall not go over the ground in reference to the theory that atoms were indivisible units of matter, except to say that most of us held in the backs of our heads reservations in regard to it. We claimed that atoms were the ultimate grains of matter—and then we were not so sure after all. The writer recalls also an evening at Zurich back in 1879 when Victor Meyer brought out his vapor density apparatus and explained his curious experience with chlorine at high temperatures; that not only did he find singular irregularities in the vapor density of chlorine, but on opening the apparatus, there developed unmistakable signs of oxygen where theretofore only chlorine was contained. There was scarcely a man present who was not willing to believe that the halogens were oxides of some primary or more nearly primary element. Later it was demonstrated that the oxygen came from rubber connections in the apparatus, but the incident is given to show how lightly chemists more than a generation ago held to the belief of the final integrity of atoms.

PERSISTENCE OF THE HIGHER CRITICISM

This question would not down. Most atomic weights constantly approximated whole numbers. In the International Table of Atomic Weights for 1912 there are 82 elements, and of these 39 are integers within one-tenth of a unit. Or, "If we consider only the elements whose atomic weights were determined by Stas, we find that two-thirds of them have atomic weights diverging

[1] "Modern Inorganic Chemistry," London, 1914, p. 816.

by less than one-tenth from whole numbers."[2] The approximation to whole numbers is greater if we consider oxygen as 16 than hydrogen as unity, but we shall not discuss that subject now.

Another disturbing feature was the family relationships exhibited in such elements as the alkali metals, the alkaline earths, the halogens, etc., and the similarity of their relationships to those among known organic bodies, such as methane, ethane, propane, butane, etc., with regular increases in molecular weights.

Again, if elements are independent entities, enduring from everlasting to everlasting without beginning and without end, why are close relatives so often associated with each other in nature? Why is silver found with lead and gold, selenium with the sulphur of pyrites, cadmium with zinc; and why do the rare earths and the platinum family almost always appear to be having a thanksgiving feast, with all branches united? Of course we can overlook or forget, but we cannot cut from the records old J. W. Doebereiner and his triads, even though he has been dead for nearly a hundred years—and the triads are definite groups. It was easy enough for London chemists to chortle and pooh-pooh Newlands into silence when he offered his theory of octaves, but after a while Mendeléef and Lothair Mayer took it up, and they built the periodic table; and then we couldn't throw it out of the house. The blamed thing was there. Prof. G. C. Foster had all sorts of fun with Newlands when he asked him if he discovered any coincidences by arranging the elements according to their initial letters, but in spite of all that it is just possible that Irving Langmuir's octet theory in regard to electrons in the presence of positive charges may light another candle at the shrine of Newlands, while Foster's acerbity loses its sharpness. More evidences of the unsoundness of the infinite and eternal theory of elements were developed from "the grouping of spectral lines, the perturbation of spectral lines, the phosphorescent spectra of the meta elements, stellar observations, electric discharges in attenuated gases, and radioactivity"—more particularly in radioactivity.

The Wages of Modesty

Prof. Richards' modesty was excessive, because he himself within a few years helped to show deviations in atomic weights that finally upset the complacency of chemists whose faith still clung to the integrity of the atom. We must note also the contributions in this respect from Professors Soddy and Honingschmidt. It was the demonstration that the atomic weight of lead varies according to the source of its origin. "Radioactive lead" (which is not appreciably more radioactive than any other kind) from thorium differs from that from uranium, and both differ from ordinary lead.

Eventually, then, we had the disintegration of the radioactive elements on the one hand, and various kinds of lead with identical chemical properties, but different atomic weights, on the other. And so the great research as to the constitution of the atom began in many places. There was Sir J. J. Thomson, who discovered positive ray analysis, and Sir Ernest Rutherford, who, among many other things, drove hydrogen atoms from an atmosphere of nitrogen. Prof. W. D. Harkins of Chicago University propounded the theory that all other atoms than hydrogen and helium were made up of aggregates of atoms of hydrogen and helium, and the brilliant young Moseley of Cambridge University pointed out shortly before his death at Gallipoli that the atomic number of elements is of more fundamental importance than the atomic weight, and that the atomic number indicates the number of free positive charges on the nucleus, and consequently also the number of electrons held about it.

With such tunneling into the very foundations of our faith in the inviolability and invulnerability and immutability of the atom, it is high time to look around and take stock of what principles we have left over.

The Requirements of Faith

Some things we must take for granted. For instance, we must agree that the hydrogen ion is one single, positively charged particle. It is the universal positive charge. Its mass is 1. When this engages an electron, which it invariably does whenever it can, it becomes a hydrogen atom. The negative particle has about one eighteen-hundredth of the mass of the whole atom. The two parts are held in leash by their opposing electric charges, but they are not in contact. The nucleus is the positive charge and the electron whirls around or about it in some manner. The atom of every other element differs from the hydrogen atom only in the number of positive charges in the center or nucleus and the corresponding number and the arrangement of electrons outside of the nucleus, with more pairs of positive and negative charges packed in between them, as we shall describe later. Please accept as the workable theory and without further explanatory introduction, that all atoms are composed of a nucleus where the positive charges are concentrated and that around and about this nucleus there are an equal number of electrons or negative charges held in leash by these positive charges. The arrangement of electrons we have previously discussed in an introductory chapter called "The Langmuir Postulates," published in CHEMICAL & METALLURGICAL ENGINEERING, vol. 21, No. 2, July 15, 1919, and the study has since been greatly augmented and developed in various publications by Dr. Langmuir himself. This theory of place rather than of orbit for the external electrons finds favor with chemists because, chemically speaking, it works. The theory of Bohr, in which the electrons revolve as planets about a sun, is in favor with many physicists, but it does not make so clear to chemists the operation of chemical phenomena. We call these electrons external or free, and the positive charges in the nucleus free for reasons that we shall take up shortly. They are nevertheless in opposition and are held together by their opposing forces.

Please take for granted also the work of Moseley and admit that the atomic number represents the number of free positive charges in the nucleus and also that of the free electrons which rotate or are held about it. With few exceptions this atomic number indicates the place occupied by each element in the order of increasing atomic weights. Thus the atomic number of hydrogen is 1, helium 2, lithium 3, and so on up to uranium, the atomic number of which is 92, and which has the highest number as well as the greatest atomic weight of all the elements.

Then if hydrogen consists of one positive charge (or proton, as John Mills calls it) and one electron, and its atomic number is 1 and its atomic weight is 1, why are

[2] James Walker, "Introduction to Physical Chemistry," 1919, p. 19.
[3] Mellor, p. 817.

not all atomic weights and numbers the same, after all? Well they're not. We have a list of atomic numbers given before and approximate atomic weights given afterward as follows: 1 hydrogen 1; 2 helium 4, 3 lithium 7, 4 glucinum 9, 5 boron 11, 6 carbon 12, 7 nitrogen 14, 8 oxygen 16, 9 fluorine 19, 10 neon 20, 11 sodium 25, 12 magnesium 24, and we can go on until we find that the rule—which, according to the Sunday School hymn, "we may almost discover"—that the combining weights are approximately double the atomic number, is not a rule at all. We have, for instance, 50 tin 119, 78 platinum 195, 79 gold 197—indeed, the higher we go the more the atomic weights run away from us. So our only safety is to disabuse our minds of this conclusion. A positive and a negative charge together represent 1. Never mind the observation that the atomic weight of many elements represents about double the respective atomic number.

No, the atomic weight, we say, is made up of the atomic number, which is the number of positive charges or protons in the nucleus plus an equal number of electrons held in leash or revolving about the nucleus (the mass of the electrons being negligible)—and then something else. The atomic number would be the atomic weight if it were not for this something else.

Atoms Not Grains

Before approaching this feature let us make a few notes about these positive and negative charges in atoms—these protons and electrons. An atom is not a compact, tight grain. The actual space or displacement of the nucleus and several electrons of an atom, compared with the space inclosed by the orbits or positions of the outer electrons, is almost negligible. One evening at the Chemists' Club Dr. Irving Langmuir said (according to the writer's recollection, and he records his apologies if his memory is at fault or if Dr. Langmuir has since revised his opinion): "If we were to magnify the diameter of an atom to the length of a mile, the electrons would have a diameter of 5 ft. each and the nucleus would be the size of a walnut." This was merely an incidental remark, and the kind of atom referred to is not remembered, but it is given to indicate how much of energy and how little of substance we have in matter, as matter. Again, it is the positive charge that has weight or mass. We read that the electron has one eighteen-hundredth the weight of a hydrogen atom. Then if a hydrogen atom consists of one proton and one electron, it is the proton that furnishes the weight, not the electron. The electron of itself is without definite mass; its mass or weight is a function of the velocity of the electron and it is always negligibly small in comparison with the proton.

Atomic Numbers and Atomic Weights

Now let us approach the reason why the atomic weight is greater than the atomic number in connection with all other atoms besides those of hydrogen.

We have been agreed for a considerable time that there must be something else besides these free protons and electrons in the atom. Atomic weight demands it. Now it is held that the excess weight is due to exactly the same elemental stuff, to some more positive charges bound to electrons somewhere within the atom, and there has been considerable discussion as to the elemental forms in which they are bound. That is, what kind of small atoms are there within larger atoms to make up the difference between the atomic weight and the atomic number of each? In this connection opinion has followed the voluminous and persuasive arguments of Prof. Harkins of Chicago in support of the belief that the excess mass consists generally of helium and hydrogen atoms. The subject has an important bearing on the cosmic history of matter. From the study of the spectrum and the rotational velocities of certain nebulas, particularly the one in Orion, it is probable that a substance of elemental nature discovered there and which appears to have an atomic weight of 3 is the original material from which creation makes its start. It is called nebulium. It appears also that the next step in the cosmic order is the development of helium and hydrogen from nebulium, and that the synthesis of all other elements proceeds from hydrogen and helium. It opens up a vast field for study and speculation, but it will do no harm to reserve decision on this until we know more than we do now.

Atomic Architecture

As to the place within the atom where this excess of helium and hydrogen is held, theory has usually packed it within the nucleus along with the free positive charges, which are present in number equal to the atomic number of the element. But lately Sir Ernest Rutherford has proposed a three-stage atom, which is a more orderly arrangement and for which he makes an excellent argument in the light of certain phases of research. This excess weight, consisting of positive and negative charges, is packed more or less closely about the nucleus and is held there as satellites, much nearer than the outer free electrons which offset the free protons within the nucleus. This makes an atom of three stages, consisting of the nucleus of free protons at the center, next the satellites as bound protons and electrons (or as helium and hydrogen), and the free electrons beyond them. The free electrons on the outer shell are those which wander to and fro and which produce all chemical reactions.

As an example of the force needed to drive satellites of hydrogen from nitrogen atoms as achieved in Rutherford's experiment by the impact of alpha particles from radium C upon the nuclei of nitrogen atoms, it is computed that if the base of each impact were magnified to 1 cm. square, there would be a blow of 10" in kilograms. That's a billion times a billion times a billion times 2.2 lb. and then a lot more, on something the size of a child's thumb nail.

Summary of the Atom

What we need to get into our minds now is that, in addition to the nucleus of every atom that holds as many free positive charges as are indicated by the atomic number, there are packed about the nucleus as many hydrogen and helium atoms as will make up the difference between the atomic weight and the atomic number. And beyond these are the free electrons of the atom that are held there by the force of the free positive charges in the nucleus. We must also remember that a positive charge counts as 1 in the atomic weight. Never mind about the fractions for the present. Also that the mass of an electron is relative to its velocity and that this is also, as mass, negligible. And finally that every atom contains the same number of electrons as it does of positive charges.

As an example let us consider an atom of tin as a

three-stage atom. Its atomic number is 50 and its atomic weight 119. Then there will be 50 free protons in the nucleus, what amounts to 69 hydrogen atoms packed about it, irrespective whether as hydrogen or as hydrogen and helium, to make up the atomic weight of 119, and 50 more electrons arranged in concentric shells on the outside, the mass of which we do not count.

The Obstreperousness of Hydrogen

Right here, however, we meet a difficulty. We have a mass of 16 for oxygen, but a little more than 1 for hydrogen. Or if hydrogen is unity, then we have a little less than 16 for oxygen. There isn't any getting around this discrepancy, either. If oxygen is 16, then hydrogen is 1.008. And since atomic weights approximate whole numbers more nearly with oxygen as 16 than with hydrogen as 1, we take oxygen as 16 and hydrogen as 1.008. That means that hydrogen atoms packed in or about a nucleus are 1 each, whereas by itself the mass of the atom is 0.008 greater. It is suggested that the increase in the single hydrogen atom is due to the lack of a "packing effect" of hydrogen and helium atoms squeezed together with great force within the nucleus or as satellites to it; that the same mass, under the packing effect of bound positive and negative charges, is 1, whereas free it is slightly more.

It is not very appealing, this theory that hydrogen and helium atoms or those positive and negative charges packed together about the nucleus of every atom should be 1, and 1.008 if free as in hydrogen itself, but let's accept it. It works out mathematically. And Mr. Aston said in his lecture at Columbia on March 15, according to the writer's notes, "By the conversion of hydrogen into helium the hydrogen loses mass of 0.008, but in doing so it generates energy. This is such that if one-tenth of the hydrogen of the sun were converted into helium it would provide for the sun's heat and light for 1,000,000,000 years."

Let's hope that no one will discover a method to accomplish this transformation for a long time to come. We are not good enough to wield such power. Indeed, if we started it we might not be able to stop it—and then where should we be? As Dr. Aston says, the result would probably be signified to the universe as a new and very bright star.

Dr. Prout's Ghost

It is well to bear in mind that the nucleus is the less studied and less familiar part of the atom, and therefore it is the more abundant field for theory, for empiricism and for the joyful art of postulation. It may be indeed that we are dealing with entities over in the realm to which Sir Evelyn de la Rue refers as "beyond numbers"; like the velocity of light, which remains constant from an approaching and from a retreating body. Sir Evelyn intimates that we might call this realm infinity, being not only beyond numbers but beyond us as well. There are Hottentots who can count up to 20, but 21 and all numbers beyond that are "many." It may be that the velocity of light and the mass of the electron will be our limit, our 21, our many, our infinity.

Now, leaving that difficulty aside, with hydrogen composed of one proton and one electron and with helium composed of two protons, two electrons and two hydrogen atoms packed inside, and with everything else made up of just such protons and electrons and hydrogen atoms, can't you see the shade of old Dr. Prout looming up again in the offing?

Isotopes Explain the Fractions

Nothing yet mentioned, however, even if we leave hydrogen out of consideration, will explain the persistent fractions in atomic weights, small though most of them are. We are postulating integral numbers for atomic weights—and they are not there. But the greater illumination which Dr. Richards was waiting for comes in good part from himself. These isotopic forms of lead point the way. If different atoms of the same element have different atomic weights but similar chemical reactions, they are isotopes. Thus we have lead atoms with the same number of free positive charges within and of electrons without the nucleus, but with a varying number of these bound sub-atomic couples or positive and negative charges packed about the nucleus. Isotopes are atoms which have the same atomic number—that is, the same number of free positive charges within the nucleus and opposed electrons outside it—but not the same number of hydrogen or helium atoms packed about the nucleus. Therefore the atomic weights of isotopes differ. And while each atom is integral, mixtures of isotopes give fractional weights. Even if we had equal portions of actinium lead 206, common lead 207, thorium lead 208 and radium lead 210, we should have an atomic weight of the mixtures of 207.5 and there is nothing to make the proportions of the different isotopes either constant or equal. So we generalize by saying that fractions in atomic weights are due to mixtures of isotopes—and then set out to prove it.

We must beware not to confuse isotopes with allotropic modifications such as is shown in the various forms of phosphorus and sulphur. There we have different geometrical arrangements of atoms within the molecules or crystals. In isotopes the differences are confined to the packing about the nuclei of the atoms. And we must not confuse the presence of isotopes with processes of radioactivity. When free positive charges and entrained electrons are thrown from a radium atom, for instance, the atomic number is reduced, and we have the transmutation of an element, the new element ceasing to be isotopic with the first.

It stands to reason that all the various isotopic forms of lead have the same chemical properties, because chemical properties are on the outside of the atom. We have in chemical activity exchanges of electrons on the outer shells of atoms, the holding of pairs of electrons in common by combined atoms and the wandering of electrons from one atom to another, thus producing ions, but in chemical processes the free positive charges in the nucleus and the H and He atoms packed within or about it are not disturbed. In radioactivity they are shot off, but not in chemical processes. So it is generally agreed, and it would seem fair to say, that the chemical properties of all the isotopic variations of an element are the same.

The Bell Rings

Having written the foregoing, the bell rang for luncheon. On the dining-room table I found my weekly copy of *Science*, vol. 4, No. 141, of Jan. 13, 1922, and there on page 42, under the head of "Scientific Events," I read that among the grants made by the Heckscher Research Foundation at Cornell University was one to

"Prof. L. M. Dennis for carrying on an investigation on the 'Separation of the Isotopes of Lead by Chemical Processes.'"

Right here is the text of as pretty a sermon in science as one could want to preach. Suppose there were a hierarchy of chemistry and we wore our academic vestments—on our minds as well as on our bodies—every day, and were insistent that we maintain unity in all the essentials of belief, restricting liberality to what we determine to be non-essentials. Then we should proceed to try Dr. Dennis for heresy and make things as uncomfortable for him as we could. But this will not do within the realm of science. If we maintain that the isotopes of an element are chemically the same, and he undertakes to separate them by chemical means, the worst we can do to him is to wait until he comes out with his findings, and then argue with him if we do not agree with his conclusions. It is a good thing for us that this is so. In the meantime let us cling to the dictum that the isotopic varieties of lead are, chemically speaking, the same, until he disproves it. We need the foundations of faith, even if they are frail.

There is no reason why atoms of different elements should not have the same mass or atomic weight, and indeed this is so, especially among the heavier elements. For instance, radium D, actinium C and polonium all have the atomic weight of 210, but have as atomic numbers respectively 82, 83 and 84. These are not isotopes. They are called isobares.

Aston's Great Work

Very important in the field of isotopes is the work of Prof. F. W. Aston of Cambridge University. He tried in 1914 to break up a gaseous element that shows a considerable deviation from an integral number in its atomic weight, and began with neon, using diffusion methods. He believed it consisted of mixed isotopes of atomic weights 20 and 22, and his experiments confirmed him in this belief. The method of diffusion is very slow, and he followed this work by the use of Sir J. J. Thomson's method of positive ray analysis, and he then brought out the amazing conclusions that no fewer than twenty elements consist of mixed isotopes the mass of each of which is invariably a whole number. A memorandum of these may be of interest.

Element	Atomic No.	Atomic Wt.	Minimum Number of Isotopes*	Masses of Isotopes in Order of Their Intensity*
H	1	1.008	1	1.008
He	2	3.99	1	4
B	5	10.9	2	11, 10
C	6	12	1	12
N	7	14.01	1	14
O	8	16	1	16
F	9	19	1	19
Ne	10	20.2	2	20, 22, (21)
Si	14	28.3	2	28, 29, (30)
P	15	31.04	1	31
S	16	32.06	1	32
Cl	17	35.46	2	35, 37, (39)
A	18	39.88	(2)	40, 36
As	33	74.96	1	75
Br	35	79.92	2	79, 81
Kr	36	82.92	6	84, 86, 82, 83, 80, 78
I	53	126.92	1	127
Xe	54	130.2	5 (7)	129, 132, 131, 134, 136, (128, 130?)
Hg	80	200.6	(6)	(197 to 200), 202, 204

*Numbers in brackets are provisional only.

Lithium proved to be a mixture of isotopes 6 and 7. Sodium is simple, apparently only of 23. Potassium shows a strong line at 39, and a weak one at 41. Rubidium shows two, at 85 and 87 respectively. Although the atomic weight of caesium, 132.81, indicates complexity, no line except that at 133 has been distinguished.

Prof. W. D. Harkins undertook the search for isotopes of chlorine, the atomic weight of which remains persistently around 35.5 and has always stood in the way of any hypothesis of integral weights. He used the diffusion method, and described it in the *Journal of the American Chemical Society*, vol. 43, No. 8, August, 1921. Since the speed of diffusion varies inversely as the square root of the density, it stands to reason that by shooting Cl, for instance, through a porous material, the lighter isotopes, if present, will tend to pass through more rapidly than the heavier. And the fruit of 7 years' labor is confirmatory of this. Repeated experiments showed the remaining chlorine which did not pass through the porous material to increase in atomic weight in the measure of 0.0318.

His first effort at separation was by means of a centrifugal machine, which was unsuccessful, but by employing diffusion apparatus, using churchwarden pipe stems and special tubes of clay, a separation of chlorine into heavier and lighter fractions was accomplished. He calculated the proportion of isotopic chlorine having the atomic weight of 37 derived from the pure HCl which he put through the apparatus to be 23 per cent.

Another lead of research has been contributed by Brönsted of Copenhagen, who evaporated mercury in vacuo upon a surface cooled by liquid air. It stands to reason that the lighter atoms which are single in mercury vapor would evaporate more readily and condense on the cool surface, and he actually found that the density of the condensed fraction was slightly less than the residue.

Present-Day Conclusions

The theoretical conclusions of today in regard to atoms and isotopes are:

1. A positive charge of proton with or without an associated electron has an atomic weight of 1, excepting hydrogen, which is slightly above unity.

2. Counting oxygen as 16, every other atom after hydrogen has approximately an integral atomic weight.

3. In the nucleus of every atom are free positive charges in number equal to the atomic number of the element. These hold in leash, either as planets revolving or within circumscribed spaces in relation to the nucleus but exterior to it, an equal number of electrons.

4. Just outside the nucleus, according to the theory of Sir Ernest Rutherford, or within it, according to the earlier theory, of each atom of elements of higher atomic number than hydrogen is the packing. This consists of bound positive and negative charges probably in the form of helium and hydrogen atoms, which affect the atomic weight, but do not affect the chemical reactions of the atom. The presence of the packing explains the excess of the combining weight of atoms above their respective atomic numbers. It also explains the presence of isotopes.

5. Fractions in atomic weights are due to the presence of isotopes in varying proportions.

In the preparation of the foregoing essay I have drawn indiscriminately on the work of Rutherford, Langmuir, G. N. Lewis, Aston, Harkins and others, without attempting in every instance to ascribe credit to the respective authors according to the contribution of each. And I desire to acknowledge the clear illumination and kindly criticism of Prof. James Kendall of Columbia University, without whose aid I should have been unable to make the present contribution.

Contributions to the Study of Ammonia Catalysts—III

Description of the Apparatus Developed by the Fixed Nitrogen Research Laboratory for the Moderate-Scale Testing of Ammonia Catalysts at One Hundred Atmospheres Pressure*

By R. S. TOUR

In a preliminary study of substances likely to be effective in catalyzing the formation of ammonia from nitrogen and hydrogen, much information can be secured by simple tests carried out at atmospheric pressure, as described in the first article of this series. Much more exhaustive tests can be carried out satisfactorily on a small scale at higher pressures by the use of such an apparatus as that previously described in the second article of this series.

However, in order to be able to decide finally on the selection of a catalyst for actual plant operation, it is essential that tests be also carried out in an apparatus of reasonably large capacity, capable of operating under conditions similar to those apt to prevail in the plant. From an apparatus of this type information may be obtained which is much more directly applicable to plant operation than that obtainable from a smaller apparatus.

Since the effective life of a catalyst is an important item in plant operation, especially in a high-pressure system where renewals are apt to be inconvenient and expensive, and since the reliability of catalyst tests depends greatly on their continuity, it is important that the testing apparatus be capable of continuous operation over long periods of time.

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*For Parts I and II, see CHEM. & MET., vol. 26, Nos. 11 and 12, pp. 493 and 555, March 15 and 22, 1922.

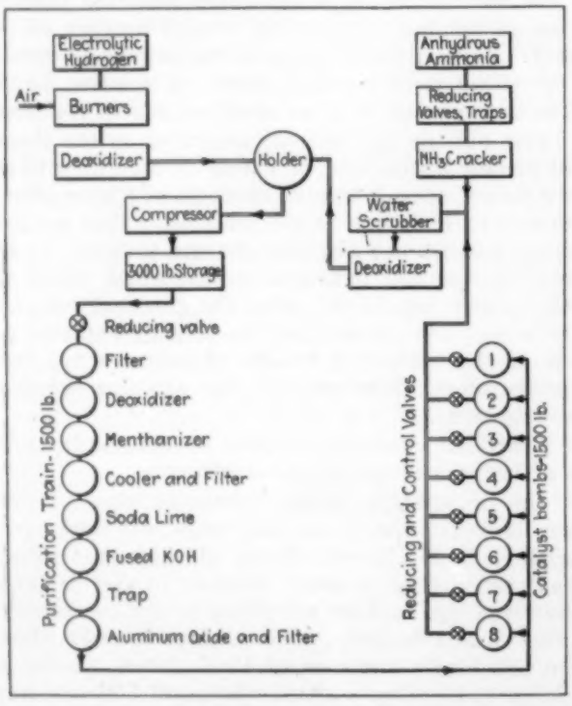


FIG. 1—FLOW SHEET OF CATALYST-TESTING PLANT

This report discusses a testing plant of the type indicated above, operated at the Fixed Nitrogen Research Laboratory. Such a plant presents many difficulties in design, construction and operation, and in its development it is inevitable that changes should be made from time to time in many items. In the main the description of apparatus is confined to the present installation and operation of the testing plant, although reference is made to apparatus and practices once employed but later modified or abandoned.

A critical study of the problem as a whole is not attempted, and therefore criticism of or comparison with other methods of achieving the same end is not included. It may be noted that the plant has to all intents and purposes operated continuously for over a year.

Early in 1916 the Bureau of Soils of the Department of Agriculture began a study of the ammonia synthesis problem and by 1917 the installation of a catalyst-testing plant was under way at Arlington, Va. In 1918 this testing plant was taken over by the Nitrate Division of the Ordnance Department, U. S. Army, and operated and developed through funds of the War Department in co-operation with the Bureau of Soils. In August, 1919, shortly after the creation of the Fixed Nitrogen Research Laboratory by the Nitrate Division, all the Arlington equipment was transferred to that laboratory.

Outline of Complete Installation

Since the detailed discussion of individual units may make difficult the visualization of the plant as a whole, a brief preliminary description of the complete set-up will be given, illustrated by flow sheets (Fig. 1) to which reference should be made in conjunction with the text.

The mixture of nitrogen and hydrogen (1:3) for testing is obtained from cylinders of liquid NH_3 which is decomposed after expansion to atmospheric pressure by being passed through a "cracker" containing electrically heated steel wool, then through a water scrubber and then through a deoxidizer of heated copper, from which it passes into the low-pressure gas holders.

From the gas holders the gas goes to compressors and is compressed to 3,000 lb. into high-pressure storage cylinders. From these cylinders it passes through an automatic reducing valve into the purification system, maintained at 100 atmospheres and consisting of a filter of glass-wool; a deoxidizer of copper, maintained at 300 to 400 deg. C.; a nickel catalyst maintained at 250 to 300 deg. C.; a water-cooled condenser and glass-wool filter; a soda-lime drier; a fused KOH drier; a dust trap; an Al_2O_3 absorber and glass-wool filter combined.

From the purification system the gas passes to the

electrically heated catalyst bombs, from which, after reduction to atmospheric pressure by appropriate valves, it passes through flowmeters, at which point samples for analysis are taken. The catalyzed gas issuing from the flowmeters passes through water scrubbers to remove the ammonia and thence back to the low-pressure gas holders for recirculation through the system.

The construction and operation of each of these items is discussed below.

Sources of Nitrogen: Hydrogen Mixtures for Testing

Up to the present the two gases have always been obtained together in the proportions desired for testing by decomposing ammonia. This is readily accomplished and yields a gas comparatively free from many impurities. Furthermore, it obviates the necessity of measuring and mixing the two gases independently.

As a future development, fifteen Electrolab cells are being installed to supply electrolytic hydrogen into which air will be injected in the proper proportion to form any desired ratio of hydrogen to nitrogen after deoxidation in a suitable apparatus.

Ammonia Cracker

Ammonia gas at atmospheric pressure obtained by expansion from standard liquid ammonia in cylinders is passed through the cracker, the final design of which

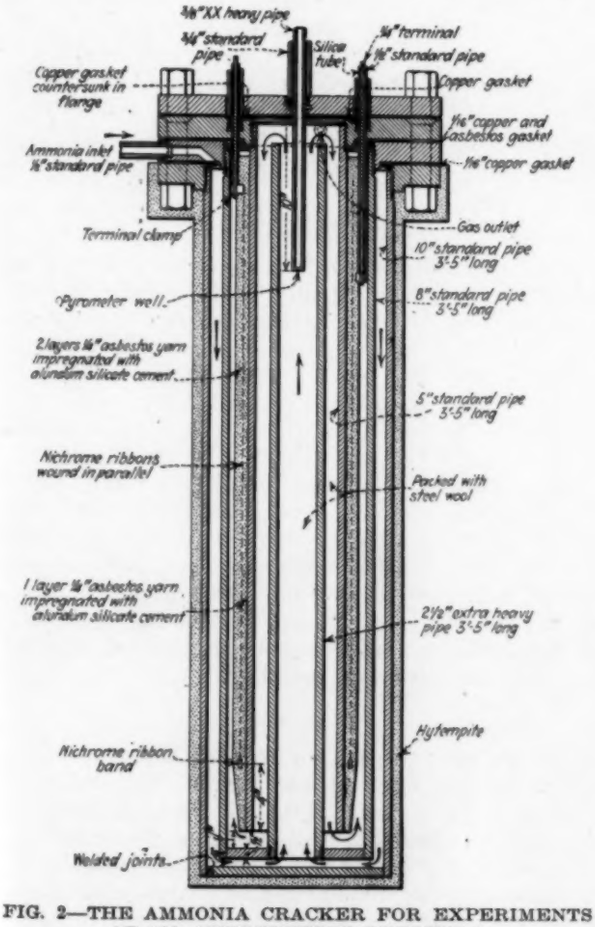

¾"XX heavy pipe
¼" standard pipe
Silica tube
¼" terminal
⅛" standard pipe
Copper gasket countersunk in flange
Copper gasket
⅛" copper and asbestos gasket
Ammonia inlet ⅛" standard pipe
⅛" copper gasket
Terminal clamp
Gas outlet
10" standard pipe 3'-5" long
Pyrometer well
8" standard pipe 3'-5" long
2 layers ⅛" asbestos yarn impregnated with alundum silicate cement
5" standard pipe 3'-5" long
Nichrome ribbons wound in parallel
Packed with steel wool
1 layer ⅛" asbestos yarn impregnated with alundum silicate cement
2½" extra heavy pipe 3'-5" long
Hytempite
Nichrome ribbon band
Welded joints

FIG. 2—THE AMMONIA CRACKER FOR EXPERIMENTS AT 100 ATMOSPHERES PRESSURE

is shown in Fig. 2. It is similar in principle to that described for small-scale testing in the first article of this series and consists essentially of four concentric steel cylinders, 10, 8, 5 and 2½ in. in diameter, arranged as shown in the figure, and all imbedded within a sheet-iron container 3 ft. in diameter, filled with 85 per cent magnesia. Around the 5-in. cylinder a heating coil of nichrome ribbon is wound, imbedded in alundum cement. The 5-in. and 2½-in. cylinders are packed with steel-wool and a pyrometer well of ⅜-in. XX heavy pipe extends into the 2½-in. cylinder. The whole apparatus is constructed of standard pipe fittings and so arranged that the heating element can be removed for repair without completely dismantling the outer shell. The ammonia gas enters at the top, passes down between the 10-in. and 8-in. cylinders for heat interchange, then up through the 2½-in. cylinder, where cracking begins, then down between the 5-in. and 2½-in. cylinders, where cracking is completed and last up and out between the 5-in. and 8-in. cylinders. The cracker operates at 600 to 700 deg. C., the heating coil taking 25 to 40 volts alternating current. The capacity is about 3 cu.ft. of cracked gas per minute. Two such crackers are maintained, one for continuous use, the other as a spare. The exit gas, containing about 0.1 per cent undecomposed ammonia, is scrubbed with water in a tower 8 in. in diameter by 6 ft. tall, packed with broken rock, the water flowing downward and the gas upward through the packing, finally leaving the tower with no ammonia remaining.

The Deoxidizer

From the scrubbers the gas may be passed when desirable through a low-pressure deoxidizer. This is essentially a piece of 4-in. standard iron pipe, filled with copper shavings and heated by a nichrome coil wound on the outside of the pipe and imbedded in alundum cement. This pipe is inclosed within the same heat-insulating shell with the cracker. The copper is kept at 300 to 400 deg. C., which suffices to reduce the oxygen content of the gas to traces.

Low-Pressure Storage

The nitrogen: hydrogen mixture, free from ammonia and practically so from oxygen, is metered by standard dry meters and a friction tube flowmeter for control purposes and goes to the holders. There are three single-lift, water-sealed, commercial gas holders, located just outside the building and fitted with heating coils to prevent the water from freezing. Two of these holders have a capacity of 500 cu.ft. each, and the third has a capacity of 250 cu.ft. All of the low-pressure gas lines to and from the holders and manifolds are of standard 2-in. and 1½-in. pipe and fittings, provided with traps, drips and drains, and tested for leaks at 30 lb. pressure.

Compression of Gases

The compressing system consists of three motor-driven standard four-stage, 4,000-lb. Norwalk compressors, two of them having 8 cu.ft. displacement per minute and one having 28 cu.ft. displacement. On the suction line to each compressor is a 10 cu.ft. tank which acts as a buffer and which is provided with an automatic vacuum alarm, warning the operator when the inlet line is under vacuum, with the attendant possibility of air being sucked into the line. The compressors, after some initial difficulties, have operated fairly satisfactorily, though requiring very careful attention and maintenance.

On its way to the storage system the compressed gas passes through a trap built up of a heavy steel cylinder

about 20 in. long by 5½ in. external and 4 in. internal diameter, fitted at each end with square forged flanges and with special internal construction to separate oil and water which is periodically blown out through a valve at the bottom.

High-Pressure Storage

The high-pressure storage system consists of twelve steel cylinders, 1.6 cu.ft. capacity. Eight of these are connected into the same manifold, which in turn is connected through standard stop valves with two auxiliary manifolds, to each of which two cylinders are connected. The piping is so arranged that two, four, eight, ten or twelve cylinders may be intermittently filled to 3,000 lb. pressure. The automatic reducing valves, one of which is used continuously, the other being reserved as a spare, are so connected to the storage that gas may be delivered from any of the above combinations of the storage system directly to the purification system at 100 atmospheres, or when desired two of the twelve storage cylinders may be used on the low-pressure side of the reducing valve as part of the purification system to increase the capacity, thereby minimizing fluctuations in the pressure. The system is fitted with gages, oil traps, safety valves and the like to insure continuous dependable operation.

It may be noted that the high-pressure manifold and the pipes which carry the gas throughout the high-pressure system are made of special double extra heavy ⅜-in. welded pipe and many of the connections, tees, unions, etc., are specially made, although standard hydraulic fittings are used where possible.

Purification of the Gas

The most important feature of the plant, other than the actual testing of the catalyst, is the purification of the nitrogen: hydrogen mixture. In order to be able to

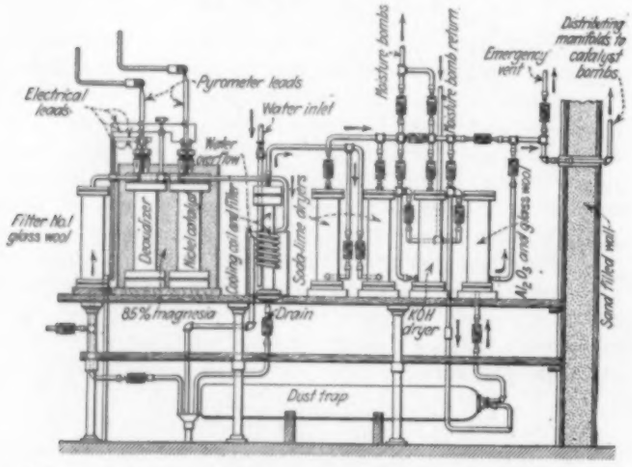


FIG. 3—PURIFICATION SYSTEM FOR EXPERIMENTS AT 100 ATMOSPHERES PRESSURE

draw intelligent conclusions concerning the behavior of the catalyst, it is essential either that the gas should be as pure as possible or that it should contain definite and known quantities of certain impurities when such are desired. The chief impurities likely to be present in gas cracked from commercial ammonia and scrubbed with water are traces of carbon compounds, moisture and oxygen, although removal of acidic constituents is provided for in the purification system. Carbon monoxide can scarcely be present in appreciable amounts, but the nickel catalyst provides for its removal.

The arrangements and connections of the various items of the purification system are shown in elevation in Fig. 3. Individual items will be discussed in more detail below.

Glass-Wool Filter

The gas from the storage cylinders passes at 100 atmospheres pressure into filter No. 1. This consists of a steel cylinder 5 in. outside diameter by 2 ft. long, fitted with flange heads and packed with glass-wool. The filter removes dust and oil which may have come over from the oil traps after the compressors.

Deoxidizer

From the first filter the gas passes to the deoxidizer, built up of a 2-ft. length of 5-in. double extra heavy chromium-vanadium seamless pipe and flanged at both ends with chromium-vanadium forged flanges. The joint used at the heads is a specially shaped tongue and groove fitted with copper gaskets. Within the deoxidizer is inclosed a steel tube carrying around it a nichrome heating element wound on alundum and incased in alundum cement. The tube is fastened to the head, which also carries the inlet and outlet connections and the electrical high-pressure terminals. The gas passes in through the head, down around the heating element and up through the steel tube, which is filled with copper turnings and maintained at 300 to 400 deg. C. The gas passes out through the steel tube through the head and to the next step of purification. Indications are that the oxygen escaping this deoxidizer is of the order of one part in one million. The deoxidizer is imbedded in 85 per cent magnesia inclosed within a sheet-iron casing. This same casing also incloses the next item of the purification train, the nickel catalyst.

Nickel Catalyst

The apparatus for the hydrogenation of carbon compounds is practically a duplicate of the deoxidizer above excepting that the inner tube carries a catalyst of reduced nickel on nonpareil brick and is maintained at 250 to 300 deg. C. The preparation of this catalyst was described in the first article of this series.

Cooler, Condenser and Filter

The hot gases pass from the nickel catalyst through a cooling coil of double extra heavy ⅜-in. pipe wrapped around a small cylindrical tower packed with glass-wool, the whole being immersed in a bath of cooling water. The gas passes down through the coil and up through the filter. The water formed in the deoxidizer is thus condensed and may be discharged through a drain at the bottom of the filter.

Driers

The gas next passes to a cylinder identical in design with the first filter of this train, filled with hard, granulated soda-lime. Two of these cylinders are arranged in parallel, but only one is in use at a time, the other being reserved as a spare. Removal of moisture as well as possible acidic impurities occurs at this point.

From the soda-lime drier the gas passes to a cylinder of similar construction, packed with lumps of fused KOH. Further removal of moisture and acidic impurities takes place in this cylinder.

From the KOH drier the gas passes into an empty steel cylinder of the type used in the storage system,

to serve as a settling chamber and to increase the capacity of the purification system to balance pressure changes.

Al_2C_3 Absorber

From the dust trap the gas passes into a cylinder similar in construction to those used as filters but containing a steel tube 2½ in. outside diameter by about 18 in. long, fastened gas-tight to the bottom head and open at the top. This tube is filled with granular colloidal Al_2O_3, which serves to remove moisture and any other readily condensible vapors, while the annular space around the tube is packed with glass-wool to act as a final filter, the gas passage being up through the Al_2O_3, down through the glass-wool and then directly to the catalyst bombs.

The arrangement of valves and pipes is so devised as to permit bypassing the gas around any unit of the purifying train when desired, and also taking off samples of gas for analysis at any point. As a matter of routine test a portion of the gas is bypassed from time to time, after the soda-lime driers and the KOH drier, through a special high-pressure bomb containing a weighed P_2O_5 tube by which moisture determinations are effected. This serves to determine the effectiveness of the preliminary drying and to indicate a need of replacing the soda-lime and KOH.

The Catalyst Bomb

The catalyst bomb represents the most important single item of the apparatus and the one whose construction and design present the greatest difficulties for successful operation. The assembled bomb, together with its heating element, is shown in cross-section in Fig. 4. Eight of these bombs are operated simultaneously.

The bomb proper is a chromium-vanadium steel cylinder, about 26 in. long by 5½ in. external and 4 in. internal diameter, fitted at each end with square chromium-vanadium flanges. The flange joints are made up with a specially shaped tongue and groove, copper gasketed joint that has proved very successful for high pressures and continually varying temperatures. The whole bomb is fastened securely to the floor for ease in assembly and is all incased in a sheet-iron container 16 in. in diameter, filled with 85 per cent magnesia.

The bottom flange is solid, while the top flange-head carries the three electrical leads to the heating elements and the catalyst tube through the center. The gas enters through the catalyst tube, which projects through the bomb head. The gas outlet from the bomb is through a passage drilled in the side of the head. On the under side of the head within the bomb is suspended the special heating element surrounding the catalyst tube.

The catalyst tube is a removable part of the bomb, permitting charging and recharging without disassembling. The portion of the tube extending above the bomb head carries a "T" connection for the gas inlet in the side and for the pyrometer well through the top. The pyrometer well consists of ⅛-in. steel tubing, which extends the full length of the catalyst tube within the bomb and permits the measurement of temperature throughout the full length of the catalyst. The catalyst tube within the bomb consists essentially of two parts, the upper portion being of steel packed with copper turnings to act as a "preheater" for the incoming gas before contact with the catalyst, and the lower portion a heavy-walled copper tube about 1 in. inside diameter which is charged with the catalyst. The copper casing aids in maintaining uniform temperature throughout the length of the catalyst.

The heating element consists essentially of a nichrome winding around a Pyrex glass tube of 1⅛ in. outside diameter. The whole Pyrex tube and heating element is imbedded in alundum cement in a sheet-iron casing, which in turn is supported from the bomb head and held concentric with the catalyst tube which it surrounds. The gas passage is, therefore, down through the preheater, then through the catalyst, then up around the catalyst tube within the heating element and out through the bomb head.

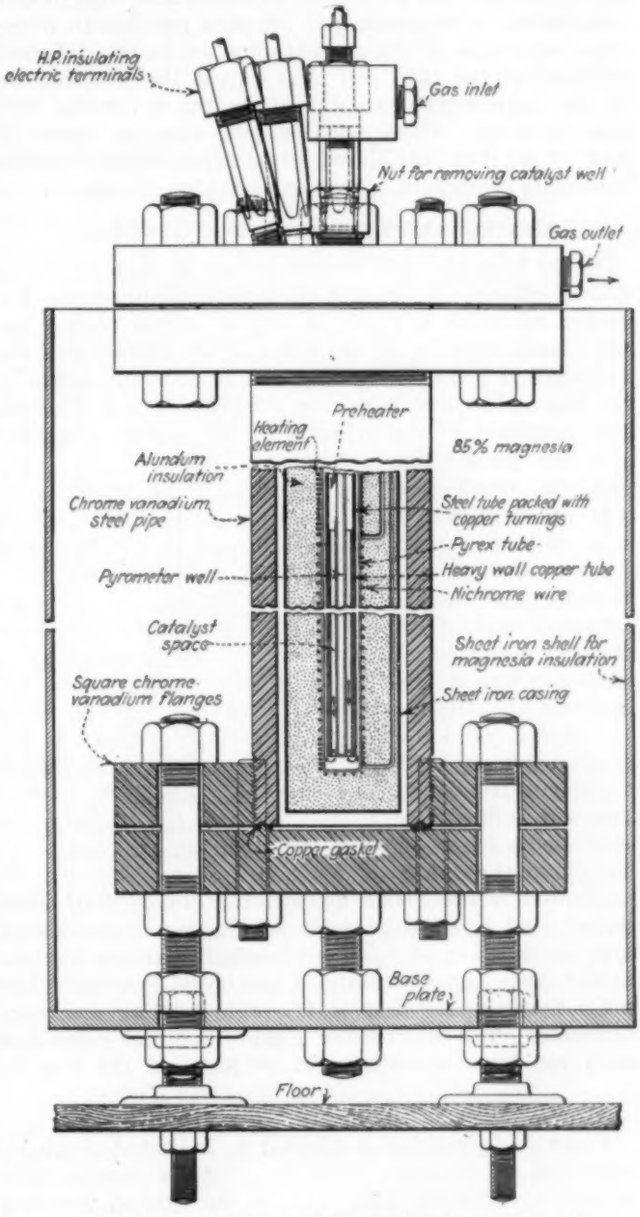


FIG. 4—CATALYST BOMB USED FOR TESTING AT 100 ATMOSPHERES PRESSURE

The design of the catalyst tube, determination of the direction of the flow of the gases and the winding and construction of the heating coil represent the results of extensive investigations whose object has been to cut down as far as possible the temperature gradient through different parts of the catalyst. Earlier designs of heating element, especially those with uniform wind-

ing and no preheater, proved on investigation to have temperature gradients as high as 200 deg. C., due partly to uneven heating and radiation and partly to localized evolution of the heat of reaction. Since the ammonia equilibrium varies rapidly with the temperature, no conclusions can be drawn as to the efficiency of a catalyst when part of its mass is 200 deg. higher in temperature than another. The method finally adopted consisted of a double winding of nichrome wire, closely wound at the top where the tube jackets the preheater, coarsely wound in the center at the location of the catalyst, and closely wound again at the bottom, where the radiation to the bottom flange of the bomb is large, has minimized this serious difficulty. Leads at top, bottom and middle are provided and with proper adjustment of resistances it becomes possible to introduce variations in the current supplied to the different portions of the tube and thus adjust the temperature as the temperature explorations in the pyrometer well may indicate. Even with widely varying rates of flow of gas it is possible with this arrangement to make the entire temperature gradient less than 10 deg. C.

Control and Measurement of Gas Flow

In the high-pressure system proper the control of gas flow is effected by the use of high-pressure valves, the design of which is given in Fig. 5. These valves are introduced between all the items of the system and are arranged to permit bypassing gas at different points in the line and also withdrawing samples for test analysis. For reduction of the pressure of the system after the gas has passed the catalyst bomb the gas passes through one of the larger high-pressure valves, then through a smaller valve[1] and finally through a section of high-pressure capillary tubing, 0.014 in. in diameter. The small valve is used for the control of the rate of gas flow. The expanded gas is measured through a calibrated friction tube flowmeter. The type of flowmeter used is a modification of the usual manometer type so much used by the Chemical Warfare Service at the American University Experiment Station.[2] The main features are that it is single reading and nonblowable. The manometer liquid is Nujol colored a deep red by a small amount of National Oil Red O.

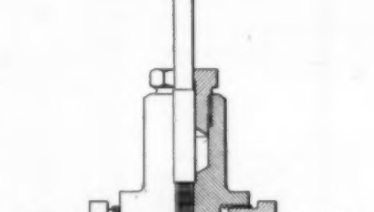


FIG. 5—STANDARD TYPE OF HIGH-PRESSURE VALVE

Control and Measurement of Pressure

Control of pressure is effected as indicated above by reduction of pressure from the high-pressure storage cylinders (3,000 to 1,800 lb.) to the desired pressure of 100 atmospheres by means of an automatic high-pressure reducing valve. The valve used is a modification of the A. W. Cash standard high-pressure piston type reducing valve. With the arrangement of storage cylinders indicated above it is possible to maintain 100 atmospheres pressure in the purification and catalyst system within 5 or 10 lb. with but occasional slight adjustment of the valve, even though the inlet pressure may vary from 3,000 to 1,800 lb. Pressure measurement is effected by Bourdon tube gages, placed on the main instrument board with the pyrometer and other measuring instruments. These gages are calibrated in place and under conditions of operation. Two Crosby recording pressure gages record continuously the pressure of the high-pressure storage and the catalyst bombs.

Control and Measurement of Temperature

Temperature control is needed in the ammonia cracker, the deoxidizers, the nickel catalyst and the catalyst chamber. Only approximate temperature control is required in the cracker and low-pressure deoxidizer, and heating there is effected by the use of a 15-kva. transformer as a source of current. The low-tension windings give a maximum of 40 volts with intermediate leads taken off to give 5-volt steps. The current through the heating elements can be thus varied by varying the impressed voltage across its terminals without the use of rheostats.

In the case of the catalyst chamber, the high-pressure deoxidizer and the nickel catalyst, this method cannot be used, because of the need of more accurate temperature control. The current used in this case is 110 volt d.c. from a 20-kw. motor generator set with a 25-kw. gasoline-driven generator for use in case of breakdown of the normal current. Plate type rheostats in series with the windings serve to control the current input and so the temperature. An ammeter and voltmeter in the circuit aid in controlling the temperature, which is finally adjusted and measured by the pyrometer.

Temperature measurement is effected in all cases by a No. 28 gage iron-constantan thermocouple, inserted into the pyrometer well. In the case of the catalyst bomb the pyrometer well extends through the entire mass of the catalyst and it is thus possible to explore the catalyst from end to end for temperature gradient.

Temperature readings are made with a Leeds & Northrup potentiometer. Two Leeds & Northrup recording potentiometers are auxiliary and maintain a continuous record of all temperatures about the plant. The couples are standardized from time to time against boiling sulphur.

Analytical Control

The ratio of ammonia formed to residual nitrogen: hydrogen constitutes the only necessary analytical determination. This is accomplished by drawing a sample of the gas through a quantity of boric acid in a bubbler to absorb the NH_3 and measuring the residual gas by a compensometer.[3] The solution is titrated with standard H_2SO_4, using bromphenol blue (tetrabromphenolsulphonephthalein) as indicator.

Introduction of Poisons Into the Gas When Desired

As previously mentioned, the two catalyst poisons removed with greatest difficulty from commercial nitrogen: hydrogen mixtures are moisture and carbon monoxide, and it is therefore desirable to study the effect of known quantities of these substances upon catalysts.

[1] See Fig. 5 in Part II of this series. CHEM. & MET. ENG., vol. 26, p. 559, 1922.

[2] See Benton, *J. Ind. Eng. Chem.*, vol. 11, p. 623 (1919).

[3] R. S. Tour, CHEM. & MET. ENG., vol. 23, No. 23, Dec. 8, 1920, p. 1104.

Moisture is introduced into the system when desired by mixing known amounts of oxygen with the nitrogen: hydrogen gas prior to compression and then passing the gas into the catalyst bomb with the deoxidizer and nickel catalyst bypassed. The oxygen reacts with the hydrogen to form water in the copper preheater of the catalyst chamber.

Carbon monoxide, prepared by passing carbon dioxide over heated carbon and then scrubbing with alkali, is introduced into the system prior to compression, the nickel catalyst being bypassed to prevent removal of CO during the operation.

Both the oxygen and the carbon monoxide are stored in a small reserve gas holder and are introduced by means of suitable flowmeters into the gas stream after it has passed the catalyst bombs and the scrubber and is on its way to the low-pressure storage.

In normal operation of the plant all readings are taken each hour and are recorded on suitable data sheets.

Conclusion

The testing plant has been used for the study of the behavior of ammonia catalysts under varying conditions of temperature, space velocity and purity of gas. These studies include consideration of the effective life of catalysts; their reproducibility; sensitiveness to and recovery from poisoning; and other factors of importance in determining the selection of a commercial catalyst.

In the fourth article of this series the results obtained with certain typical catalysts in the apparatus described in this and the preceding articles will be discussed.

World Production of Coal in 1921

The world's production of coal in 1921 dropped back to the level of 1909. From reports so far received, the United States Geological Survey estimates the total output at approximately 1,100,000,000 metric tons. This figure is subject to material revision as more complete returns are available.

In comparison with the feverish year 1920, the year just closed shows a decrease of more than 200,000,000 tons. The chief factors in the decrease were the British miners' strike, which lasted from April to June, and—more important—a world-wide industrial depression. Prices collapsed early in the year, and the seaborne coal trade of the world fell off sharply. The consequent reduction in the volume of business offered to the shipping of the world has been an important element in the decline in ocean freight rates, so keenly felt by the American merchant marine.

Of the major coal-producing nations, France and Germany were the only ones to show an increase. Progress in restoring the ruined mines of France is indicated by the steady increase in output of the past 3 years. In 1919, 22,000,000 tons was produced; in 1920, 25,000,000; in 1921, approximately 29,000,000. A further increase of 12,000,000 tons, however, would be necessary to bring French production up to the level of 1913. German production of bituminous coal is also still far below the pre-war level, although an increase was effected in 1921 as against 1920. German production of lignite in 1921 reached the highest point ever attained. The estimated output of 120,000,000 tons is an increase of 33,000,000 tons over the last year before the war.

The proportion contributed by the United States was 40.9 per cent, a larger share than in the years before the European war, but the smallest in any year since 1916.

The following table presents the information received by the Geological Survey up to Feb. 15, 1922. The tonnage of the countries not yet heard from ordinarily amounts to 12 or 15 per cent of the total. Receipt of data for these missing countries, estimates for which are included in the total, may raise or lower the final figure by some millions of tons. The unit used is the metric ton of 2,205 lb., the approximate equivalent of the long or gross ton. It is not, however, exactly the same, and the translation from net or gross tons to metric tons gives many of the figures an unfamiliar look.

PRELIMINARY ESTIMATE OF THE WORLD'S COAL PRODUCTION

(In metric tons of 2,204,622 lb.)

Country	1919	1920	1921
Australia	10,736,321	13,176,426	(a)
Belgium	18,342,950	22,388,770	21,807,160
British India	22,991,217	17,356,889	(a)
Canada	12,411,328	15,088,175	13,300,000
China	23,000,000	19,500,000	(a)
Czechoslovakia	26,946,813	31,086,479	(a)
France	22,341,000	25,300,000	29,000,000
Germany—Coal	(b) 116,500,000	(b) 140,757,433	(b) 145,400,000
Lignite	93,800,000	111,634,000	120,000,000
Japan	31,461,386	29,245,384	(a)
Union of South Africa	9,313,232	11,181,846	(c) 9,400,000
United Kingdom	233,467,478	233,216,071	166,992,000
United States	502,534,410	586,000,000	448,600,000
Other countries	46,553,865	49,068,527	(a)
Totals	1,170,400,000	1,305,000,000	1,100,000,000

(a) Estimate included in total. (b) Includes Saar and Upper Silesia. (c) Estimated from 11 months' production.

Neither 'Nor Nor 'Noxide

A product resulting from a number of processes applied to an ore is not to be classed as an ore. A decision to the foregoing effect has been handed down by the United States Court of Customs Appeals in the case of Tower & Sons versus the United States. The question arose over an importation which was assessed by the Collector of Customs as oxide of cobalt. The importer contended that it should be admitted free as "cobalt and cobalt ore." The importation was in the form of a heavy grayish black powder. It was admitted that the product was a residuum after the natural ore had been subjected to various treatments. The ore had been roasted, it was testified, to eliminate the arsenic. It then had been treated with an acid to concentrate its soluble components. A part of the residuum was precipitated, filtered, dried and ground. The court held that the product could not be classed as an ore after these treatments. Incidentally the testimony developed that it could not be classed as oxide of cobalt, since the analysis disclosed that it contained 28 per cent of oxide of nickel.

Preheating High-Speed Tools

The Bureau of Standards is testing a number of ½-in. lathe tools made of several brands of high-speed steel. One interesting point brought out in the early work is the apparent influence of preheating before hardening. Using the average of four tools, made, heat-treated and tested under the same conditions, except for preheating temperature, the results were as follows:

Preheated 20 Min. at	Hardening Heat (5 Min.)	Quenching Medium	Pounds of Metal Cut
1,400 deg. F.	2,417 deg. F.	Oil	9.1
1,500 deg. F.	2,417 deg. F.	Oil	10.1
1,600 deg. F.	2,417 deg. F.	Oil	5.1
1,600 deg. F.	2,417 deg. F.	Water	5.1

The steel in question analyzed 0.6 per cent C, 3.5 per cent Cr, 15.5 per cent W and 1.6 per cent Va.

The Control of Tuberculosis in Industries

By James A. Aupperle

THIS article covers the disease of pulmonary tuberculosis as found among the employees of our industries. A change of environment is suggested which will mitigate this disease and increase the worker's efficiency. It is an established fact that the occupation one follows has a decided effect upon pulmonary tuberculosis. In some occupations the workers are immune from this disease and in other occupations the death rate from tuberculosis is very high.

The purpose of this paper is to present the facts as we find them in the hope that tuberculosis will be mitigated by a change of environment.

It is an established fact that tuberculosis is nonexistent in certain occupations and an analysis will be made of these occupations in order to arrive at conclusions for combating this disease.

Nieszytka[1] reports that 76.5 per cent of all deaths among the sandstone workers in Hanover are due to tuberculosis. This is ten times as many deaths from tuberculosis as occur among workers in limestone. The difference is due to the fact that sandstone is siliceous and does not dissolve, while the limestone is readily dissolved by the carbonic acid present in the lungs. The particles of sandstone are sharp and irritate the tissues, which then present a fertile field for the entrance and growth of tubercle bacilli. The chances of contracting the malady are hastened by a run-down, weakened condition of the human system due to disease, vice or alcoholism.

Rotation of Work a Remedy

Many of the large trusts control so many industries that the efficiency of the tuberculous workmen can be increased by a scientific rotation of work. If an employee, on account of occupation or predisposition to pulmonary tuberculosis, can have a change of occupation, the disease will not only be arrested but the employee will get well and be of more economic value to the employer and the community.

Dampness is conductive to tuberculosis, as is evidenced by the fact that in the Philippine Islands and seacoast cities the mortality from tuberculosis is extremely high, while it is very low in dry states like Arizona, Colorado and New Mexico. The effect of dampness is counteracted by other agencies, so that if there is present a germ-destroying sulphur gas, such as hydrogen sulphide, sulphurous acid or sulphuric acid, the danger of contracting tuberculosis is reduced to a minimum. Various sulphur gases are found in coal mines, and although damp and at times dusty, the coal miner is practically immune from the disease, and those employed in coal mines have the lowest death rate from tuberculosis. Their average age at death is 51.3 years, while in all other occupations the average age at death is 47.9 years.

There is an abundance of sulphur dioxide and sulphur trioxide gases in the Pittsburgh atmosphere—in fact, there is so much that these compounds in the air cause the rusting of steel sheets to such an extent that iron sulphate forms on the metal. On the other hand, the death rate from tuberculosis in Pittsburgh is lower than any other large city in the United States. Pittsburgh is a smoky city where the large consumption of coal containing sulphur produces the germicidal sulphur gases.

Immunization by Sulphur Gases

Plaster of paris—calcium sulphate—is a combination of lime and sulphuric anhydride. This compound, when breathed into the lungs, ionizes to lime and sulphuric anhydride, the lime as bicarbonate is absorbed by the tissues and rendered harmless, while the sulphuric anhydride in the presence of water and carbon breaks up into carbonic acid gas and hydrogen sulphide gas, and is thus eliminated from the system. Calcium sulphate has such germicidal properties that in one German plaster of paris establishment there have been no cases of tuberculosis in 17 years. In another plaster of paris establishment in France tuberculosis is practically non-existent.

Selkirk[2] tells us that no workers around limekilns have died from tuberculosis. The probable reason is that coal which contains sulphur is used in limekilns and the production of germicidal sulphur gases is responsible for the non-existence of tuberculosis in this industry.

The smelter fumes in Colorado and Arizona contain large amounts of sulphur gases. In some cities the sulphur dioxide can be tasted in the air breathed. Tuberculosis is practically unknown in these districts, except in those who have contracted the disease elsewhere and who have gone to these districts to get well.

Furnace tenders are practically immune from tuberculosis, and here again we trace the beneficial effect of sulphur gases which are derived from sulphur in the coal.

In the manufacture of sulphuric acid the employees are practically immune from tuberculosis.

A sailors' and soldiers' health camp has been established at Hilo on the Island of Hawaii. It is located on the brink of one of the world's wonders, the ever-active volcano of Kilauea. The wonderful results obtained at this health resort are of world-wide renown. Tubercular patients show immediate improvement when sent to this resort. The volcano is continually giving off gas containing a large percentage of sulphur dioxide gases which is responsible for the mitigation of tuberculosis.

Large Organizations Can Help

The virtual trusts now being formed will be very useful in helping to stamp out tuberculosis. A careful survey of occupations in a large steel trust will give a good idea as to how the men with tuberculosis can be given employment where there is a possibility of curing the disease and increasing the worker's efficiency.

The following are among the jobs which should be given to men with tubercular tendencies:

Coal mining, furnace tending, cement manufacture, lime burning, manufacture of sulphuric acid, manufacture of gypsum, galvanizing where sulphur is burned, roasting of sulphide ores or wherever a small amount of sulphur gases are present from the burning of sulphur.

With the well-organized medical departments, employment and mutual interest departments, our large industries should find it an easy matter to follow the health of employees who may be given employment in departments which may mitigate tuberculosis.

Middletown, Ohio.

[1] Vrtljschr. f. gerichtl. Med., Berlin, 1912.

[2] *J. Am. Med. Assn.*, Dec. 12, 1908.

Effects of Impurities on Electrolytic Zinc

Photographs of Cathodes Made in Commercial Cells After the Addition to the Electrolyte of One or Two Parts Per Million of Arsenic, Antimony, Cobalt, Copper, Nickel and Glue —Severe Action Commences Several Hours After Addition

By GUILFORD DARBY SCHOLL

THE Keokuk, Iowa, plant of the River Smelting & Refining Co. was built in 1915 and started operating in 1916, treating the zinc "fume" produced at a plant in Florence, Col., from the complex zinc-lead-copper-silver sulphides of the Colorado district when smelted by a process of roasting and reverberatory smelting.

Naturally ores of the nature treated contained impurities in varying amounts and as the Keokuk plant was entirely an experimental unit, it took several years in which to work out a successful refining process to recover the zinc as "Grade A Electrolytic." Satisfactory results were finally obtained, but not until after the close of the World War, when the zinc market had become completely demoralized.

During the 3 years of operation there were periods when production was seriously threatened by the action of impurities in the solutions. A number of tests carried out in the commercial cells were run during the closing months of operation to determine, if possible, the characteristic effects of foreign elements in the electrolyte.

Fig. 1 illustrates the arrangement of the electrodes in the cells in which the tests were made. The neutral solution entered the top cell of a cascade of four, but this flow was supplemented by an auxiliary feed into each of the three lower cells to maintain zinc concentration as constant as possible in all the cells. Fig. 1 also shows the position of the cooling coils, rubber connections and iron water and waste pipes.

In conducting the tests, the electrodes as well as the cells were thoroughly cleaned and then cut into service for an hour or two before the impurity was added. At the start sufficient "dope" solution, as it was called, was poured into the cell to give the volume of cell solution a certain predetermined content in the element under consideration. Thereafter at hourly intervals enough impurity was added to maintain this concentration. Doubtless a better plan would have been to add the impurity continuously, especially in the case of elements that deposited out with the zinc, as opposed to those that acted as catalytes.

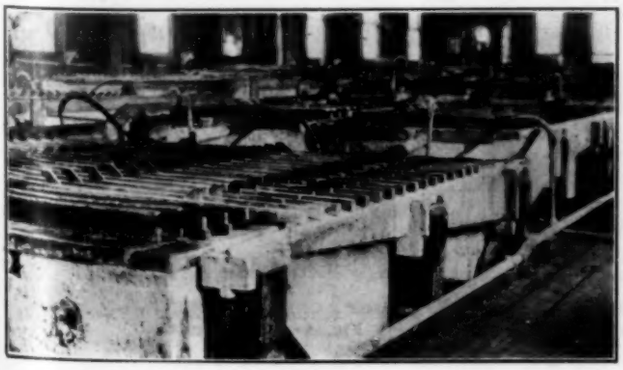


FIG. 1—CELL IN WHICH TESTS WERE MADE

The duration of a test was 48 hours—the regular stripping interval—but in numerous cases the deposit had to be stripped before this time, owing to the violent action of the impurity in redissolving the zinc faster than it was being plated. Individual cathodes, however, were removed and the zinc was stripped from time to time to obtain samples representative of the stages in the action of the impurity. From these sheets of zinc and from others taken at the end of the tests, 8-in. squares were cut and photographed. They are reproduced in this article at about one-quarter size to illustrate the effects of foreign elements upon the electrolytic deposition of zinc.

The electrolyte employed in the cells was as pure a zinc sulphate solution as it was possible to make. In fact it was a great deal purer than the so-called c.p. zinc sulphate of commerce. It ran between 70 and 80 g. per liter in zinc and varied from zero to 6 per cent in free sulphuric acid. In this article is treated only one phase of the varied and interesting experience encountered at Keokuk.

Arsenic

Sufficient arsenic solution was added to the bottom cell of a cascade to bring the content in arsenic up to one part per million. This ratio was then maintained by hourly additions. After 20 hours of deposition a cathode was removed and stripped; Fig. 2 represents the incoming solution side of the zinc deposit. Although this sheet shows nothing distinctive, yet a close examination with a magnifying glass reveals characteristics which appear more definite in succeeding photographs.

A second test followed directly upon the first and in the same cell, but the content in arsenic was increased to two parts per million. This ratio was maintained by hourly additions. After 26 hours of deposition sheet Fig. 3 was taken out. In this sheet the typical arsenic effect, as interpreted, is evidenced by the shattering of the carrot-like bamboo structure which in itself appears to indicate too much antimony in the electrolyte. Arsenic eats holes through the deposit, not only in the bottom of the recesses between the rough bamboo structure but also through the joints of this formation. The rear of arsenic-affected sheets is black around each corrosion center, with a corresponding black residue opposite on the cathode. This is in striking contrast to antimony-affected deposits.

A third test followed immediately upon the second and also in the same cell and with the same proportion of arsenic. A sheet pulled out 33 hours after the start of deposition is shown in Fig. 4. This illustrates more clearly the character of deposit yielded by arsenic. Note the similarity between this sheet and that of Fig. 3, only the effect has been intensified.

Another sheet, shown in Fig. 5, was taken out after 37 hours run and Fig. 6 shortly thereafter. Fig. 7 was

withdrawn 43 hours after the start of the test. The last three illustrate the progressive steps in the corrosion as the deposits grow older. The sheets are shot full of holes and show in a more positive degree the presence of too much arsenic in the electrolyte. Deposits of this kind naturally dross heavily in the melting furnace.

Efforts were made to detect arsine (AsH_3) in the faint sulphuric acid vapor arising from the cell, but while one trial, using a conical hood with a small vent in the top, indicated what might have been taken as a faint trace, yet it was not conclusive enough to warrant the statement that arsine is given off from a cell having arsenic as an impurity in excess of a harmless quantity.

Tests made in experimental cells by Dr. Mighill indicated that arsenic up to one part in a hundred thousand caused a serious loss in current efficiency.

Antimony

The effects of antimony are striking and distinctive. The zinc deposit is characterized by an imperfect carrot-like bamboo structure in sheets from 23 to 30 hours old and by a cauliflower-mushroom deposit in sheets 48 hours and older.

Into the bottom cell of a cascade enough antimony solution was poured to bring the content in antimony to one part per million, and thereafter enough fresh solution was added hourly to maintain this ratio.

Four hours after the first addition of antimony solution a sheet was stripped and found to weigh 179 g. per square foot, while a sheet of the same age from a regular cell weighed 237 g. per square foot. A piece of zinc from both samples was placed in the ordinary plant

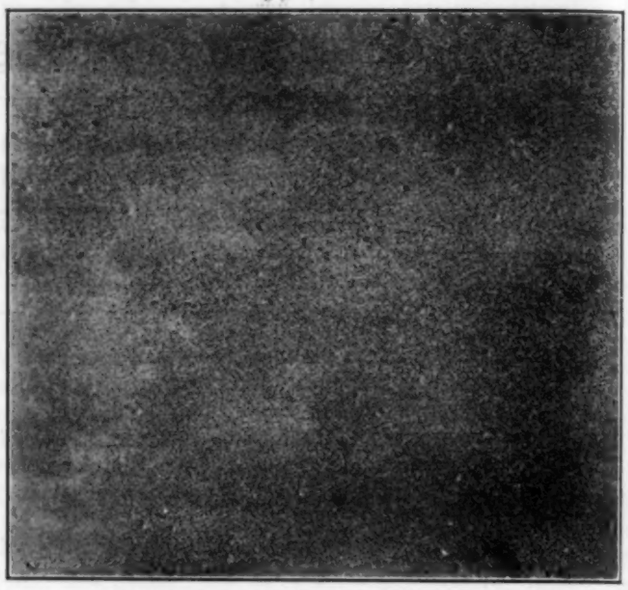
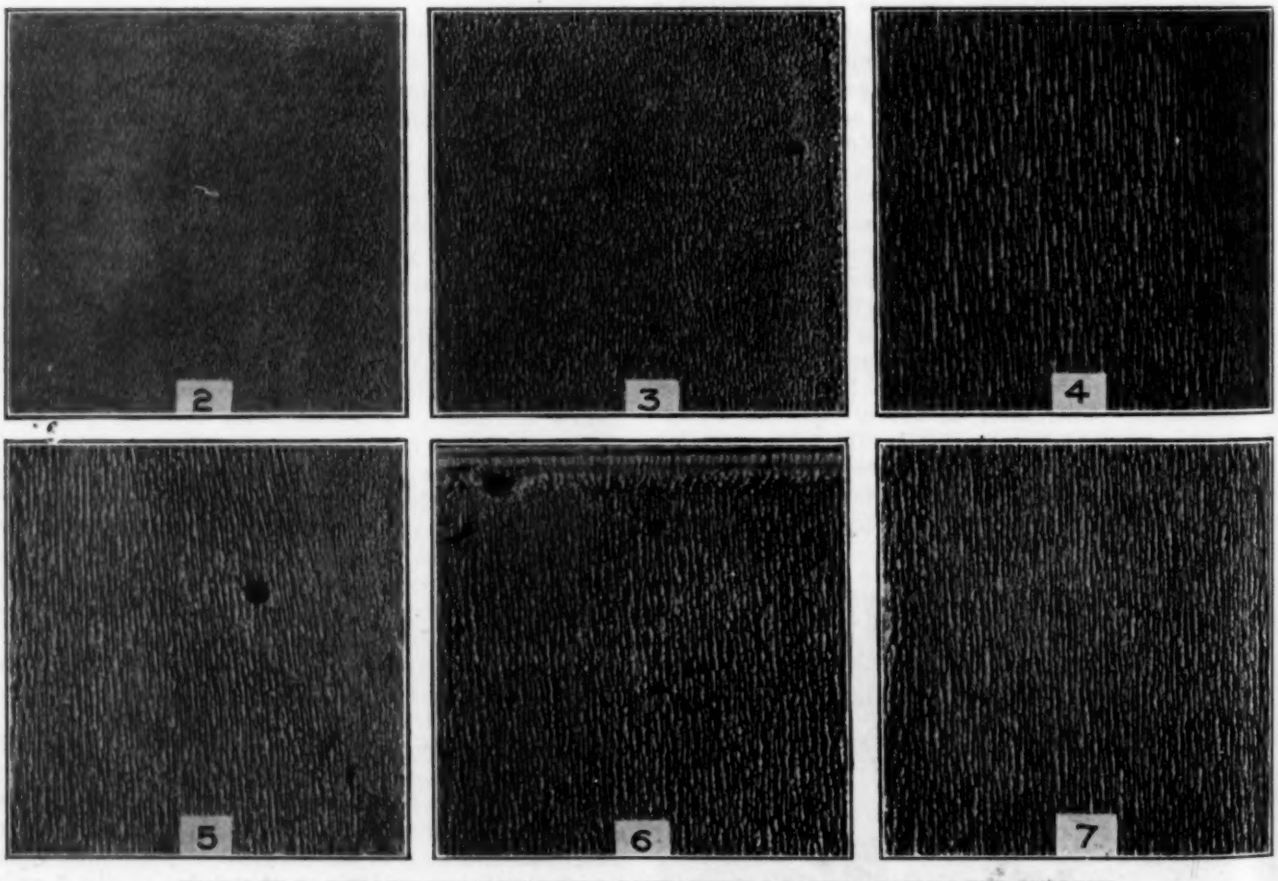


FIG. 8—FULL-SIZED CATHODE; POROUS AND LACY FROM RE-SOLUTION INDUCED BY ANTIMONY

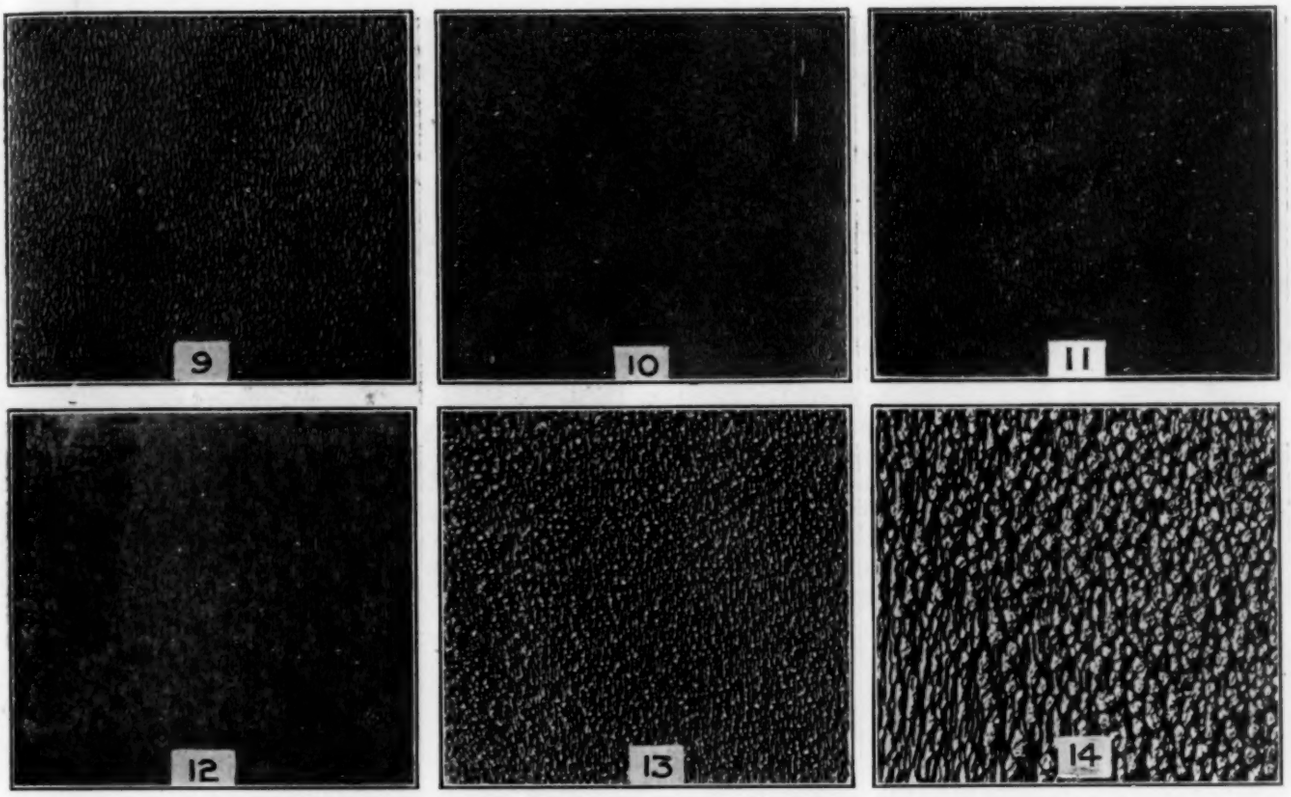
electrolyte and the rate of solution observed. The piece from the antimony cell dissolved just six times as fast. The surface of the antimony sheet was granular, while that of the sheet from the regular cell was smooth and of a bluish cast of color.

Fig. 8 shows a full-sized sheet that was stripped from the test-cell. The evidence of corrosion is plainly to be seen in the characteristic antimony structure. The



FIGS. 2 TO 7—DEPOSIT FROM SOLUTION CONTAINING 2 PARTS ARSENIC PER MILLION

Fig. 2—20-hr. deposit, arsenic 1 part per million.
Fig. 3—26-hr. deposit.
Fig. 4—33-hr. deposit.
Fig. 5—37-hr. deposit.
Fig. 6—38-hr. deposit.
Fig. 7—43-hr. deposit.



FIGS. 9 TO 14—DEPOSIT FROM SOLUTION CONTAINING 2 PARTS ANTIMONY PER MILLION

Fig. 9—34¾-hr. deposit. Antimony 1 part per million.
Fig. 10—6¾-hr. deposit.
Fig. 11—11-hr. deposit.
Fig. 12—21-hr. deposit.
Fig. 13—26¼-hr. deposit.
Fig. 14—26½-hr. deposit.

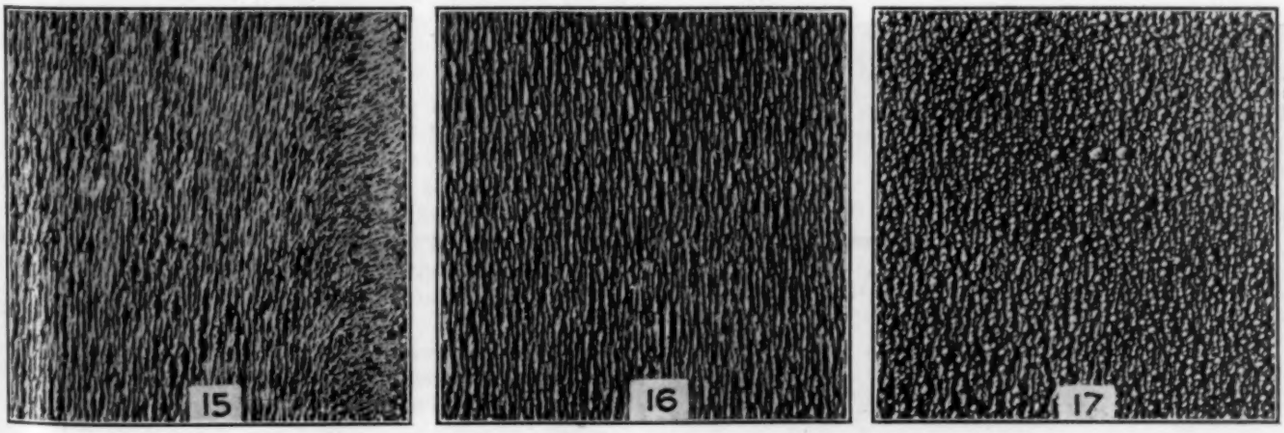
sheets were literally peppered with holes. In fact, there was very little weight left, the sheets being practically a lace-work of zinc.

After 30 hours deposition two sheets were stripped from the test-cell and the cathodes were replaced by new blanks. The zinc showed a distinct carrot-like bamboo structure on the surface and was beginning to redissolve very rapidly. At 34¾ hours the cell had to be stripped. Fig. 9 of the accompanying photographs shows this structure.

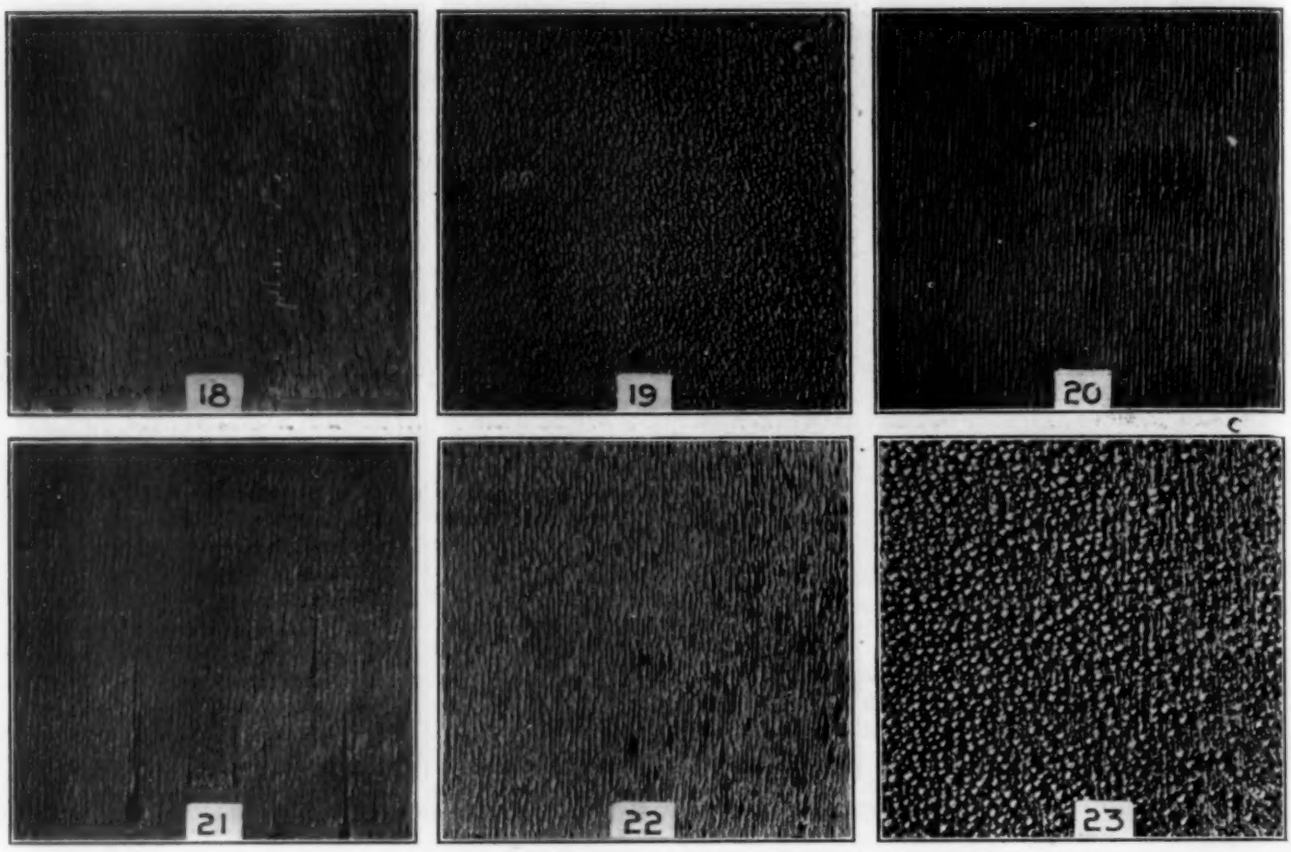
A test of the electrolyte of the cell after the zinc had been stripped revealed not the slightest indication of antimony. It would seem from this result that antimony is plated out. A test of the zinc from this cell did show antimony.

Another test was run in the top cell of a cascade in which two parts per million of antimony were added and successive hourly additions of the solution made for 48 hours to maintain this ratio. Fig. 10 shows a sheet 6¾ hours after the first addition of the "dope" solution, and Fig. 11 illustrates a sheet 11 hours old. Both reveal the action of antimony. A cathode put in the cell to replace that which yielded sheet shown in Fig. 10 was stripped 21 hours later and gave the plate represented by Fig. 12. Fig. 13 shows characteristic antimony effects. It is a sheet from the same cell, 26¼ hours old. The test run had to be discontinued before the sheets were 30 hours old, owing to the rapidity with which the sheets were dissolving. In these tests the zinc sheets were eaten away until there was only a thin backing or skeleton on the aluminum cathode, while the deposit was characterized by a growth such as is shown in Figs. 13 and 14.

A marked difference between the action of antimony



FIGS. 15 TO 17—COMMERCIAL CATHODES PRODUCED BY ELECTROLYTES CONTAMINATED BY ANTIMONY AND OTHER ELEMENTS



FIGS. 18 TO 23—DEPOSITS FROM SOLUTIONS CONTAINING COBALT

Fig. 18—22-hr. deposit. Cobalt 4 parts per million.
Fig. 19—34½-hr. deposit. Cobalt, 2 parts per million.
Fig. 20—48-hr. deposit. Cobalt, 2 parts per million.
Fig. 21—48-hr. deposit. Cobalt, 2 parts per million.
Fig. 22—Defective commercial cathode.
Fig. 23—48-hr. deposit. From cell below test cell.

and that of any other impurity is the total absence of black spots on the cathode, even though the deposit is literally peppered with holes.

Both Figs. 15 and 16 show evidence of the presence of too much antimony in the electrolyte. These sheets were taken from the cellroom nearly a month after the two special tests described above were run. It was evident from these sheets and others, like Fig. 17, that antimony was one of the elements that had been causing frequent trouble in the cellroom for the entire period of the operation of the plant. The degree of its effect, however, varied, depending of course upon the concentration of this element. There were periods when its effect was very slight.

It is quite possible that other plants have had similar or different results from the impurity antimony. I am of the opinion, and I think all will agree, that if one element alone is present in the electrolyte or present in a predominating amount, a distinctive effect is made upon the physical character of the zinc deposit, and in most cases is recognizable. On the other hand, when two or more impurities are present and in about equal proportions, it is almost if not entirely impossible to distinguish the effects as due to this or that element.

From the experience gained at Keokuk and under the conditions of the scheme of operations employed, it can safely be concluded that the presence of antimony in the electrolyte in excess of one part in five million is decidedly objectionable. Test-cells run by Dr. Mighill in the laboratory indicated a current efficiency of only 85 to 90 per cent even at this dilution.

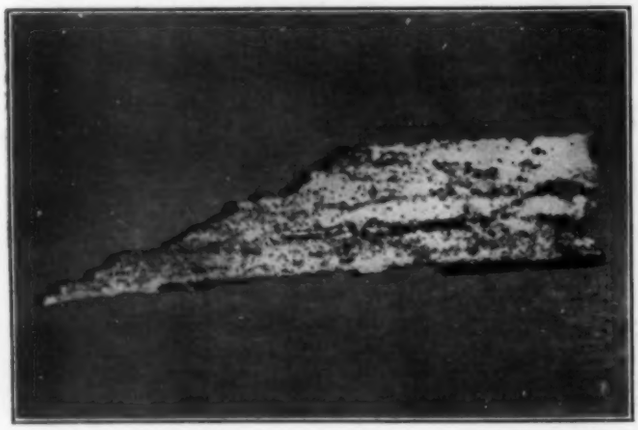


FIG. 24—POROUS DEPOSIT FROM A PITTED CATHODE

Cobalt

In an effort to obtain some characteristic effects of cobalt upon the deposition of zinc, enough cobalt solution was added to the bottom cell of a cascade to bring the cobalt content in the electrolyte to four parts per million, the manganese content at the same time being 0.023 per cent. The addition of the cobalt solution was made after the deposit on the cathodes was 1½ hours old and enough solution was added hourly to maintain this ratio.

Instructions were left to report immediately any unusual occurrences. Twenty-two hours later the cell was "going bad." Within half an hour the sheets were inspected, having been withdrawn from the cell in the meantime. Fig. 18 is a photograph of a sample taken

from the sheets. The surface of the deposit was characterized by a blunt fibrous structure, showing excessive corrosion. The test had not proceeded far enough, however, as the weight of zinc indicated a current efficiency of over 80 per cent. A piece of zinc from this cell placed in the ordinary electrolyte dissolved just twice as fast as a piece from an adjoining cell. Under the microscope the former showed very smooth edges, while the zinc from the ordinary commercial cell which had not been "doped" was comparatively sharp. In the light of subsequent experience this test showed that the critical period between the deposition and the action of the cobalt had been reached.

Another test was run, using the top cell of a cascade, but with only two parts per million of cobalt in an electrolyte containing 0.021 per cent manganese. This content was maintained for 48 hours. As neutral solution alone was flowing into this cell, more striking results were expected. Fig. 19 shows a sheet 34½ hours old, very badly corroded but still having considerable weight. In this sheet the fibrous structure can be recognized, although disguised by its knotty character. A sheet from the same cell 15½ hours old but taken from the outgoing solution side of the cathode revealed nothing of value, it being only slightly roughened.

On the other hand, Figs. 20 and 21 illustrate the character of the deposit when the cell was stripped at the end of 48 hours. The similarity to Fig. 18 is apparent, although the fibrous structure shown in Fig. 20 is sharper and the sheet shown in Fig. 21 very porous, the latter being practically a skeleton.

These tests demonstrated the extremely dangerous action of cobalt when present in the electroylte in an amount from one part per million and upward.

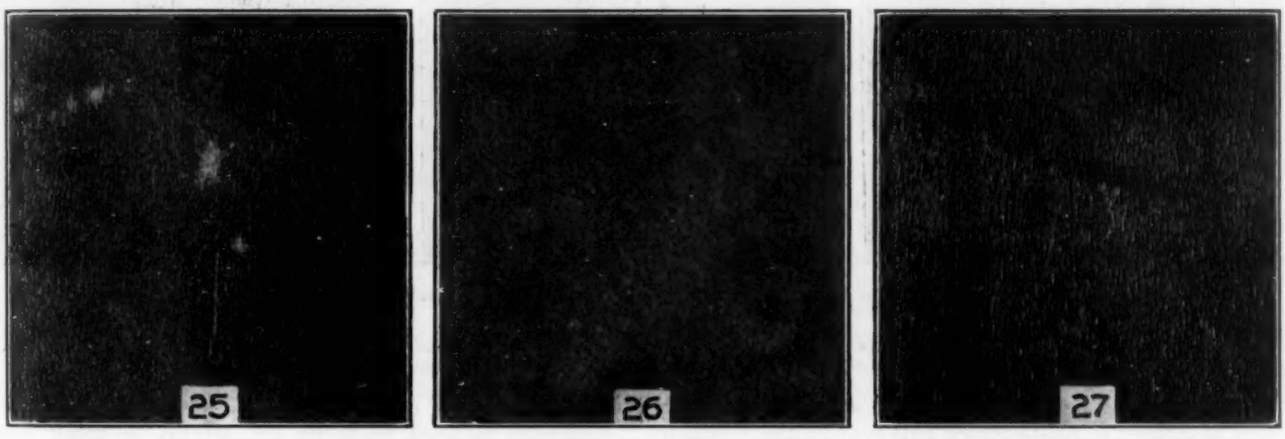
While Fig. 22, which represents a typical sheet of zinc from the day's production, is similar in appearance to Fig. 20, yet the fibrous character is not as sharp nor the corrosion as deep, the deposit being considerably heavier.

Another striking effect of cobalt is shown in Fig. 23, which represents a 48-hour sheet taken from the cell next below the test-cell. The corrosion here is very marked and appears to be an advanced stage of Fig. 19. However, such contrasts are not unusual and often are explained by the position of the sheet in the cell. The side of a cathode facing the inflowing solution will almost invariably show the more marked and characteristic effects of an impurity. Then, too, cobalt appears to have a more virulent effect upon the deposit in the cells next below that which has been "doped" with the impurity.

Fig. 23 tends to support the supposition that some impurities do not reach their maximum effect upon the zinc deposit until they have been in the cells for some time. It is reasonable to believe that they enter into other forms or compounds under the action of the electric current or in association with other impurities in the cell or both.

Effect of Condition of Cathode

Fig. 24 shows the back of a fragment of a zinc sheet which was deposited upon a badly pitted cathode. This test was run to demonstrate that a badly corroded and pitted aluminum cathode will invariably yield a porous zinc plate, the holes in the deposit corresponding to the pits in the cathode. The test also gave supporting evidence to the idea that impurities in an electrolyte are much less active when the cathodes are clean and smooth than when they are rough and pitted. To confirm this view, 300 g. of the fragment (which, by the way, was not taken from the cobalt test cells) and 300 g. from a first-class zinc deposit of the same day were run for cobalt. The fragment showed a trace of cobalt, about one in five million, while the sample from the first-class deposit revealed no cobalt whatever.



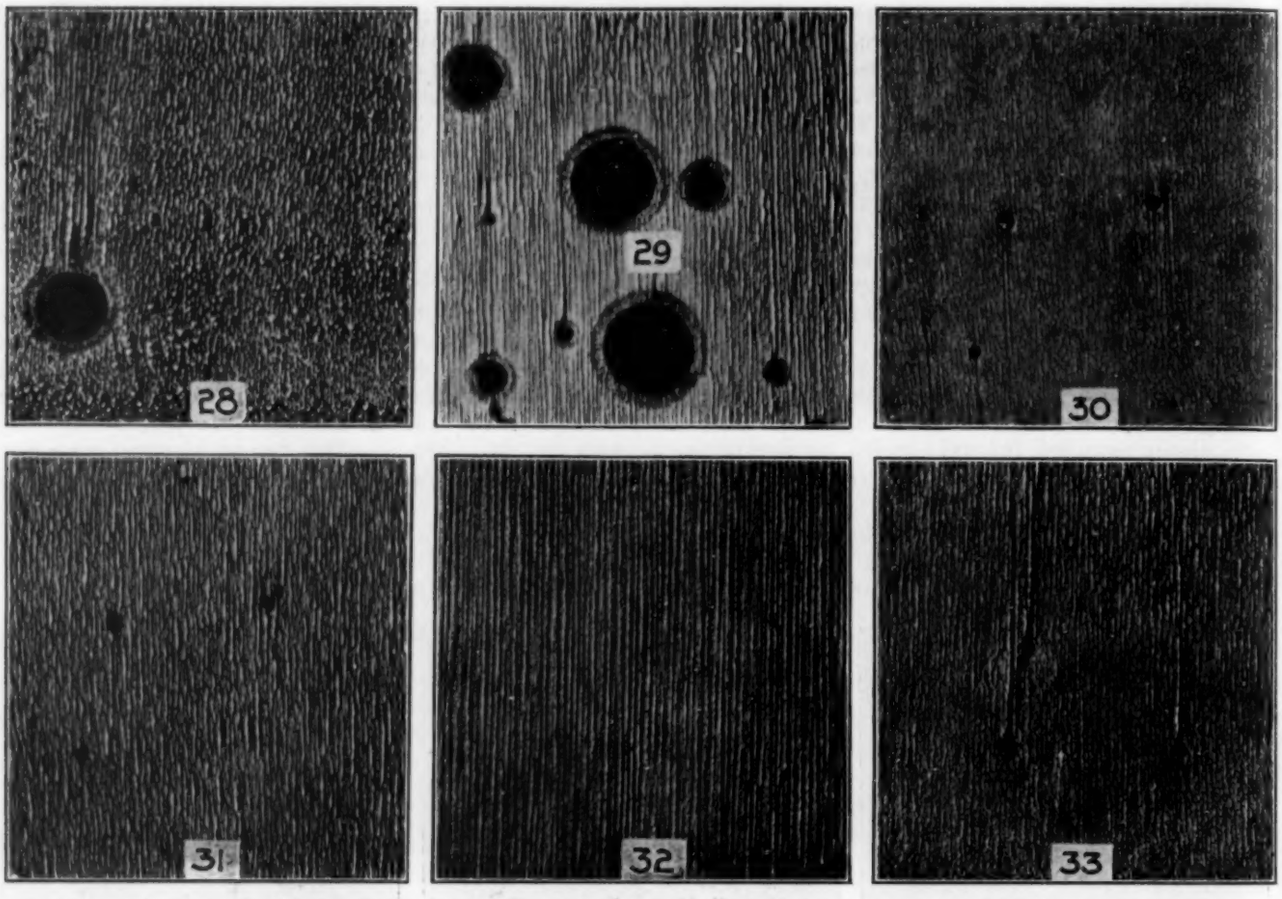
FIGS. 25 TO 27—48-HR. DEPOSITS FROM SOLUTIONS CONTAINING 2 AND 5 PARTS COPPER PER MILLION

Copper

It was known that copper was an undesirable element in the electrolyte, for whenever it rained any leaks through the cellroom roof dripping down upon the electrodes invariably streaked the deposits by washing copper sulphate from the copper conductor bars to the zinc deposit. The zinc would dissolve away wherever the copper solution came into contact with the plates, leaving the aluminum bare, but these plates would "heal" again after the dripping stopped.

To find the permissible limit of copper in the solution, cells were run using two and five parts of copper per million respectively. Apparently, however, these amounts had little effect upon the zinc deposit; the samples Figs. 25, 26 and 27 taken from the cells after 48 hours show nothing distinctive. Small test-cells gave a current efficiency as high as 92 per cent with one part per hundred thousand of copper.

The tests indicated that copper to a concentration of even five parts per hundred thousand might not be dangerous. Sufficient time was not left before the close of operations to go any further with the copper tests.



FIGS. 28 TO 33—DEPOSITS FROM SOLUTIONS CONTAINING NICKEL WITH PERHAPS COBALT AND ARSENIC

Fig. 28—Characteristic nickel rings.

Fig. 29—Characteristic nickel rings.

Fig. 30—17½-hr. deposit. Nickel 2 parts per million.

Fig. 31—32½-hr. deposit. Nickel 2 parts per million.

Fig. 32—48-hr. deposit. Nickel 2 parts per million.

Fig. 33—48-hr. deposit. Nickel 2 parts per million.

It can readily be appreciated that when the accumulation of copper sulphate which gathered on the conductor bars between stripping operations or through a period of 48 hours was washed down over the zinc deposit the strength of this solution in copper was considerably more than the limits used in the tests. Its action, therefore, while striking, was not an indication of what was to be expected from the ordinary electrolyte whose content in copper was comparatively very low.

It is consequently reasonable to conclude that the amount of copper ordinarily occurring in zinc sulphate electrolyte is not a factor of any moment in the corrosion of the zinc deposit, or, in other words, has not a serious influence upon the current efficiency.

Nickel

Effects that were later distinguished as characteristic of nickel had been noted in the cellroom deposits upon several occasions during the period of operations. In Figs. 28 and 29 the distinctive effect of nickel is shown in the "nickel ring," which is a concentric banded border surrounding a corroded area. A delicate pink color fringes the area and shades off to a dusty brown or black in the outer bands.

A special test-cell was run, adding sufficient nickel solution to make its content two parts per million of nickel. Fig. 30 shows a deposit 17½ hours old, Fig. 31 a sheet 32½ hours old and Figs. 32 and 33 sheets 48 hours old. An attempt was made to reproduce in this cell the characteristic nickel effects illustrated in Figs. 28 and 29, but without marked success. It was concluded that the concentration in nickel had not been sufficient, as tests made by Dr. Mighill in small laboratory cells showed an efficiency of 85 per cent with electrolyte "doped" with one part nickel in a hundred thousand.

It also appeared that nickel was more influenced in its action than any of the other elements by the presence of additional impurities in the electrolyte. Cobalt and arsenic effects can be detected in Figs. 30 to 33, their presence evidently retarded the usual effects of nickel.

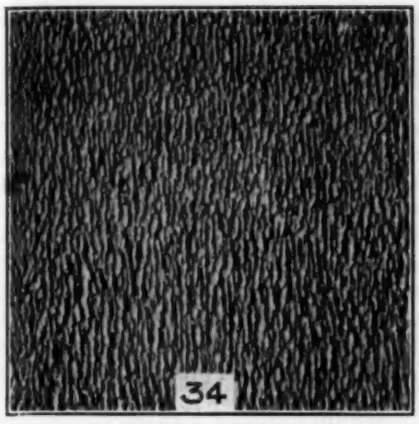
Outside of the "nickel ring" marking, electrolytes having too much nickel will produce zinc sheets that are porous and consequently light in weight.

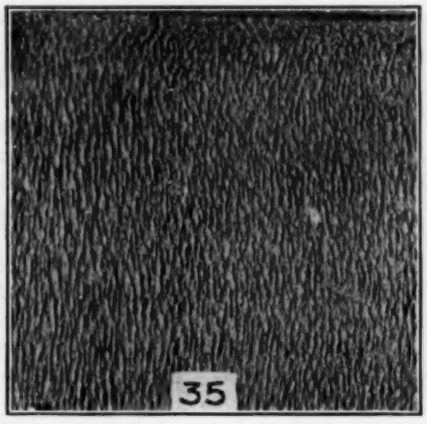
There is a similarity between the effects of cobalt and nickel in the fibrous structure, although the nickel sheets appear lighter in color and more regular in their physical characteristics.

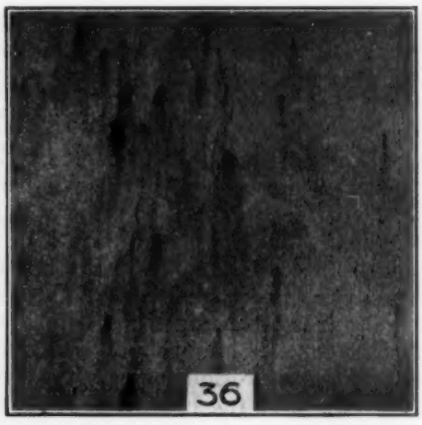
Miscellaneous Impurities

On a number of occasions the zinc deposit stuck so tenaciously to the cathodes that it was very difficult to strip the sheets. Figs. 34 and 35 illustrate sheets of zinc that were typical of deposits persisting for several days while the sheets stuck badly to the cathodes. Although Fig. 34 shows the effects of antimony, yet Fig. 35 is not distinctive but resembles more nearly a cobalt effect in its early stages. A great deal of speculation was indulged by various members of the staff upon the cause of "sticking" sheets, but no explanation actually fitted the phenomenon.

Tests conducted during the latter part of 1917 and







FIGS. 34 TO 36—MISCELLANEOUS TROUBLESOME SHEETS

Fig. 34—"Sticker"; probably affected by antimony.

Fig. 35—"Sticker"; cause unknown, possibly cobalt.

Fig. 36—Ferric hydrate working out through pores.

early in 1918 proved in a convincing manner that rough and pitted cathodes caused "sticking" of the deposit and furthermore, as noted above, that a badly pitted cathode invariably produced a porous deposit (Fig. 24). The sticking of the zinc, however, during the winter and spring of 1919 was on a more extensive and persistent scale than any previously experienced. It is quite likely that the accumulation of impurities or the presence of new impurities in the electrolyte had a contributing influence.

In this connection it should also be noted that a cathode that is too smooth will not retain a zinc deposit; it will break away as its age increases, and in some cases it actually falls into the cell or strips itself.

Colloidal Ferric Hydrate

Fig. 36 illustrates the action of re-solution, the brown streaks having been caused by gaseous action at the base of the deposit, working the "muck" out through the tiny holes in the zinc plating. In this case the "muck" was a ferric hydrate mud which had collected in the solution lines between the cellroom and the Dorr thickeners used for iron purification. It is a colloidal substance, almost non-filterable.

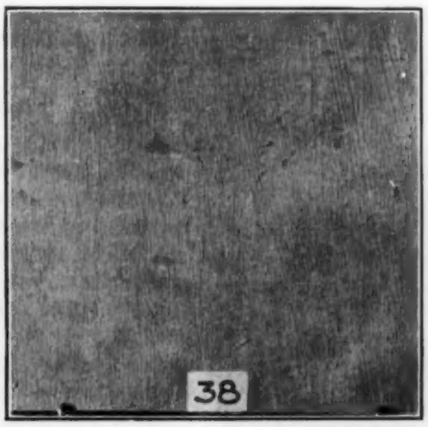
A number of test-cells were run to see what effect quantities of this "muck" would have upon the deposit. It was thought that it might carry the arsenic, antimony, cobalt, etc., and thus be the source of the many bad times the cellroom had experienced. However, the large cells that were doped with this muck did not reveal anything of interest. The zinc deposit was good and the current efficiency as high as in clean cells.

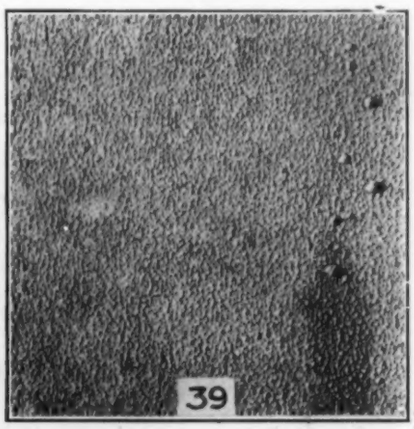
Glue

Whenever glue was omitted from the cells for a time, the deposit would become full of holes. This is undoubtedly due to the action of impurities which are rendered either inert or retarded in action by the glue. Fig. 37 shows a sheet that has healed after glue had been added to a cell previously free of glue. Fully half of the sheet had been dissolved away and then plated over, as evidenced by the raised patches.

The addition of glue after its total absence for some time causes a marked and almost instant change in the deposition of zinc. In one case the entire cellroom was in trouble, the sheets were peppered with holes and in some cases were actually on the verge of breaking away from the cathodes. The situation was acute, many remedies were suggested and many ideas were advanced to account for the condition, cobalt and nickel being the popular culprits. Glue was added and within 20 minutes a change had come over the entire cellroom. Re-solution had been arrested and in the great majority of cases the sheets had actually "healed" and plating had been resumed. From this and several no less striking experiments one cannot but conclude that glue has a deterrent effect upon the action of impurities.

A first-class, dense, hard crystalline deposit of zinc is shown in Fig. 38. A sheet of this character is very smooth; it is of good weight and will represent a cur-





FIGS. 37 TO 39—COMMERCIAL CATHODES

Fig. 37—Defective sheet healed with glue additions.

Fig. 38—First-class cathode.

Fig. 39—Satisfactory "pebbly" deposit.

rent efficiency in the 90's. In Fig. 39 is shown the characteristic "pebbly" deposit. It is an indication of good plating and high efficiency.

Conclusion

The tests brought out the fact that impurities, as a general rule, when within reasonable limits do not attack the zinc deposit very vigorously during the first 15 or 20 hours of deposition. While it has been shown by Tarbell, for example, that the action of cobalt is catalytic, yet it appears that there is likewise either a preliminary concentration before the catalytic action starts, or the impurity is changed into another state before the corrosion begins. It is also quite possible that the effects of the impurities thrown out of solution or formed under the electrolytic action in the cell under test, or in the preceeding cells when the former is not a top cell, might easily retard or disguise the true effects of the particular impurity under investigation. The time was too limited to extend the experiments to determine these points.

It is of course evident that the phenomena noted in these tests can be variously interpreted by different investigators. In several instances, however, the evidence appeared so convincing that the conclusions drawn should be of value as a basis for further investigation.

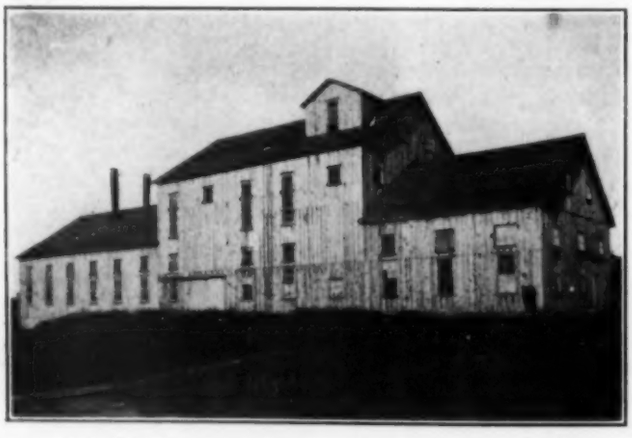
Keokuk, Iowa.

Fullers Earth Deposit Opened in Pennsylvania

THE Furness Corporation, with main office in Chicago, has opened up a deposit of high-grade fullers earth on a 270-acre tract located at Clarksville, Mercer County, Pa. The mill, located on the Pennsylvania Railroad, is about ready to operate. Power for the mill is supplied from a plant consisting of two 150-hp. Phœnix boilers, Reed feed-water heaters and one 350-hp. Hamilton Corliss engine. Water and fire pumps operate in conjunction.

The mill plant is equipped with a Marine Iron Works disintegrating mill. Material, after passing this unit, is run through two Cummer's rotary driers. From the driers it feeds into a No. 12 Brainard hammer mill, where the first stage of pulverizing takes place.

This unit has a feed opening of 5 x 12 in. and will pulverize 5 to 8 tons per hour, of which 90 per cent will pass through a ¼-in. mesh. The hammers weigh 100 lb. each and come in contact with the earth on the upstroke. The hammer shaft has a speed of 400 to 600 r.p.m.



FULLERS EARTH MILL AT CLARKSVILLE, PA.

The material next passes into the Kneutzberg pulverizers, which operate to distribute all the coarse material in such a way as permits all the applied power to be used for actual grinding. The result is a maximum of fines with a minimum of power consumption.

Tyler whip-tap screens follow the pulverizer, and from these the finished product finally lands in the storage bins. Material is handled between units of the plant by screw conveyor equipment, all furnished by the Weller Manufacturing Co. The plant has a capacity of 60 tons per 8 hours. Installation of a dragline excavator with steam shovels at the pits is contemplated.

Some Uses of Fullers Earth

Fullers earth obtains its name from its original use in fulling cloth, extracting the greases from the wool. Its principal use now is bleaching and clarifying or filtering oils, fats and greases and is alike applied to animal, vegetable, seed and mineral oils.

It is used in the manufacture of coconut butter, oleomargarine, cold-water paint and wall paper and in detecting certain coloring matter in food products. Its use is gradually extending, it being employed as a substitute for talcum powder, as a poultice and as an antidote for alkaloid poisons.

A common practice in filtering mineral oils is to dry the earth carefully and then grind it to a suitable mesh and run it into long cylinders through which the crude, dark mineral oils percolate slowly. The result of this practice is that the oil coming out first is perfectly white and much thinner than that which follows. The oil is permitted to percolate through the earth until its color reaches a certain maximum shade.

A radically different process is followed in filtering vegetable, seed and animal oils. In this case the oil is heated in large tanks beyond the boiling point of water, from 5 to 10 per cent of its weight of fullers earth is added and the mixture is vigorously stirred and then filtered off through bag filters, or filter presses. The coloring matter remains with the earth, likewise any foreign matter which the oil may contain, the filtered oil being a pale straw color, providing, of course, the operation has been performed with sufficient care.

New uses, such as deliming hides in the manufacture of leather, may be developed and in time create a good market for the absorbing fullers earth.

Fullers earth cake from oil mills can be used in the manufacture of hand soaps, concrete waterproofing and asphalt preparations.

Fluorspar Production in 1921

The fluorspar shipped from mines in the United States in 1921, according to H. W. Davis, of the U. S. Geological Survey, amounted to approximately 35,600 short tons, valued at $708,000, a decrease of 81 per cent in quantity and of 85 per cent in value as compared with 1920. The general average selling price per ton f.o.b. cars at shipping points for all grades of fluorspar in 1921 is estimated at $19.89, which is $5.37 less than the average price in 1920. The total shipments in 1921 were the lowest recorded for any year since 1908.

The imports of fluorspar into the United States in 1921 totaled 6,229 short tons, as against 24,612 tons in 1920, a decrease of 75 per cent in quantity and of 74 per cent in total value.

Non-Flammable Mixtures of Organic Solvents for Vegetable-Oil Extraction

Experiments With Gasoline, Benzene, Carbon Tetrachloride and Trichlorethylene Indicate That Fire Hazard Can Be Eliminated More Economically by the Use of Certain Mixtures of Flammable and Non-Flammable Solvents Than by Extraction With Pure Non-Flammable Solvents

By A. F. Sievers and J. D. McIntyre

In the commercial extraction of vegetable oils by means of organic solvents one of the chief technical considerations is the selection of a suitable solvent. Three important factors enter into such a consideration: (1) Initial cost of the solvent and the thoroughness with which it can be recovered, (2) safety from fire hazard and the relation of such hazard to the cost of plant insurance, and (3) the quality of oil obtainable by the use of the solvent. The relative importance of these three factors depends to some extent on the character of the material to be extracted and the purpose to which the extracted oil is to be put. Economy of operation is at all times of paramount importance, hence the first two factors are closely interrelated. The third factor is probably of less importance, especially when the solvent used is sufficiently pure to admit of its complete removal from the extracted oil.

It is well known that the several solvents commercially practicable for extraction purposes have a selective action on substances other than the fat in the oleaginous material, notably the pigments. In a previous paper,[1] however, the writers have shown that in the case of the solvents gasoline (high- and low-boiling fractions), benzene, carbon tetrachloride and trichlorethylene when used in connection with such materials as cotton seed, soya beans, corn germs and peanuts, there is no relation among the color of the crude extracted oil, the color of the finished oil and the refining loss. It would seem, therefore, that so far as regards the four principal solvents—gasoline or naphtha, benzene, carbon tetrachloride and trichlorethylene—the question of the selective action is of secondary importance, the main considerations being economy and safety.

Purpose of the Experiments

Of the four solvents mentioned the two chlorinated hydrocarbons are non-flammable and the other two are flammable. Three are chemical entities with definite boiling points when pure, while gasoline is a mixture of hydrocarbons with a boiling range depending on its grade and quality. It was the purpose of the experiments recorded in this paper to determine the ratio in which the non-flammable and the flammable solvents must be mixed to make the mixture safe and to what extent such mixtures will fractionate into unsafe fractions when recovery is effected by direct heat or with a current of steam.

The chlorinated hydrocarbons are much more expensive than gasoline or benzene. While the latter solvents cost about 30c. a gallon, carbon tetrachloride and trichlorethylene cost about $1.35 a gallon (1922 quotations). It is evident, therefore, that if a considerable proportion of a cheap, flammable solvent can be mixed with the more expensive but non-flammable one, and if the resulting mixture will not fractionate into unsafe fractions upon recovery, the fire hazard can be eliminated with an appreciably lower cost than if pure non-flammable solvents were used.

[1] Sievers, A. F., and McIntyre, J. D., "The Relative Effectiveness of Several Organic Solvents for the Extraction of Vegetable Oils," *Cotton Oil Press*, vol. 4, February, 1921, p. 44.

Preparation of Solvents

The benzene and trichlorethylene for the following experiments were used without further treatment, but the trichlorethylene was somewhat yellow and was consequently distilled over a direct flame to obtain a colorless product. The gasoline was obtained from ordinary motor fuel by means of distillation under reduced pressure. The portion boiling below 85 deg. C. under a 25-in. vacuum was retained for use in these experiments.

TABLE I—BOILING RANGE OF THE SOLVENTS—GASOLINE, BENZENE, CARBON TETRACHLORIDE, AND TRICHLORETHYLENE

Fraction c.c.	Temperature (Degrees C.) Gasoline	Benzene	Carbon Tetrachloride	Trichlorethylene
Start*	65	73	58	60
5	90	81	75	87
10	96	81.3	76	87
15	104	81.5	76.7	87.5
20	110	81.6	77	87.5
25	116	82	77	87.7
30	122	83	77.5	87.9
35	130	84	79	88
40	141	85.5	81	88.8
45	162	87	85	90
50†	...	89	90	90.5

* Reading when the vapors began to pass into the condenser.
† In the case of gasoline only a portion of the last 5 c.c. actually passed over into the condenser; the remainder condensed on the sides of the flask.

In order to determine the boiling range of the several solvents, 50 c.c. was distilled over a direct flame and the temperatures noted after the collection of every 5-c.c. fraction. The results are shown in Table I.

Method of Testing

In testing the flammability of the several mixtures it was sought to copy as nearly as possible the conditions under which explosions or fires would most likely occur in an extraction plant—namely, the discharge of a spark in an atmosphere of the vapors of the mixture. The most likely source of ignition of such vapors in a plant is probably an electric spark such as might come from a motor. For testing purposes an automobile spark plug was suspended in a 300-c.c. beaker. By means of a hot plate the beaker was kept sufficiently hot to vaporize immediately the 2 c.c. of solvent introduced. In the midst of these vapors the spark was discharged at frequent intervals. Those mixtures which did not burst into flame from the spark were considered suffi-

TABLE II—SPECIFIC GRAVITIES OF THE MIXTURES IN SERIES *A*, *B* AND *C*

Mixture	Proportion (by Volume) Non-flammable (a) Per Cent	Proportion (by Volume) Flammable (b) Per Cent	Specific Gravities at 25 Deg. C. Series *A* (a) Carbon Tetrachloride (b) Benzene	Series *B* (a) Trichlorethylene (b) Benzene	Series *C* (a) Carbon Tetrachloride (b) Gasoline
	100	0	1.586	1.458	1.586
2	95	5	1.547	1.429	1.542
3	90	10	1.514	1.400	1.499
4	85	15	1.480	1.369	1.456
5	80	20	1.444	1.342	1.412
6	75	25	1.405	1.310	1.368
7	70	30	1.372	1.281	1.327
8	65	35	1.333	1.250	1.283
9	60	40	1.301	1.221	1.240
10	55	45	1.265	1.190	1.195
11	50	50	1.228	1.162	1.153
12	45	55	1.193	1.133	1.110
13	40	60	1.156	1.104	1.068
14	35	65	1.120	1.075	1.025
15	30	70	1.084	1.044	0.980
16	25	75	1.052	1.015	0.940
17	20	80	1.017	0.986	0.898
18	15	85	0.978	0.958	0.859
19	10	90	0.941	0.928	0.811
20	5	95	0.908	0.898	0.770
21	0	100	0.871	0.871	0.728
Difference in specific gravity between 1 and 21			0.715	0.587	0.758
Difference in specific gravity for every 1 per cent change in proportion			0.0072	0.0059	0.0076

ciently non-flammable to make their use in an extraction plant reasonably safe.

Preparation of Solvent Mixtures

Three series of mixtures were prepared: (*A*) Carbon tetrachloride and benzene, (*B*) trichlorethylene and benzene and (*C*) carbon tetrachloride and gasoline. In each case mixtures were prepared ranging from 95 per cent of the non-flammable and 5 per cent of the flammable to 5 per cent of the non-flammable and 95 per cent of the flammable. The specific gravities of all these mixtures are tabulated in Table II.

By the method previously described these various mixtures were tested for flammability. In series *A* it was found that 30 per cent by volume is the maximum safe proportion of benzene which can be used. In series *B* only 20 per cent by volume of benzene can be used. This shows the relative extinguishing power of the trichlorethylene and carbon tetrachloride. The gasoline as used in these experiments is evidently less flammable than benzene, since 35 per cent by volume can be used with carbon tetrachloride in series *C*. The foregoing proportions are, of course, not absolute, because with the method of testing used a difference of 1 or 2 per cent in the percentage cannot readily be detected. The proportions decided upon in the three series as being safe mixtures are all well within the safety margin. It must be understood, however, that the above mixtures are considered safe when used as such, without reference to what degree of fractionation may take place when such solvent mixtures are being recovered in an extraction plant. This phase of the matter will be taken up in the subsequent paragraphs.

Direct Distillation of Solvent Mixtures

In a solvent-extraction plant the operation most likely to lead to a leakage of solvent vapors is probably that of the recovery of the solvent either from the oil or from the residue. It is of utmost importance, therefore, that such mixtures of solvents as have been described must not only be non-flammable as such but must not fractionate upon recovery to such an extent that flammable vapors will be produced at any stage of the recovery operation. The three series of mixtures selected, which will be designated as I, II and III, were submitted to distillation under various conditions to determine the extent to which such fractionation takes place. The mixtures were first distilled directly on a steam bath, 500 c.c. being used and 50 c.c. fractions collected. The temperature at the start of each fraction was noted and the specific gravity of each fraction taken to determine the proportion of the two solvents present in the mixture. The results of these distillations are given in Tables III, IV and V.

TABLE III—RESULTS OF DIRECT DISTILLATION OF 500 C.C. OF A MIXTURE OF 30 PER CENT, BY VOLUME OF BENZENE AND 70 PER CENT OF CARBON TETRACHLORIDE. (MIXTURE I.)

Fraction	Temperature (Deg. C)	Specific Gravity at 25 Deg. C.	Proportion of Components (by Volume) Benzene	Carbon Tetrachloride
1	70	1.381	28.7	71.3
2	77.5	1.379	29.0	71.0
3	78	1.379	29.0	71.0
4	79	1.377	29.3	70.7
5	81	1.376	29.4	70.6
6	81	1.374	29.7	70.3
7	81	1.372	30.0	70.0
8	81	1.368	30.6	69.4
9	80.5	1.364	31.7	68.3
10	83–84	1.345	34.0	66.0

Specific gravity of mixture before distilling, 1.372
Specific gravity of all fractions mixed, 1.373.
Time of distillation, 1 hour, 5 minutes.

The extent of the fractionation in the case of the mixture in Table III was relatively small. The final fraction, which contained the largest proportion of benzene, was carefully tested for flammability and found to be safe. It is evident, therefore, that mixture I can be safely distilled by direct heat, because at no stage of the operation are the vapors flammable.

TABLE IV—RESULTS OF DIRECT DISTILLATION OF 500 C.C. OF A MIXTURE OF 20 PER CENT, BY VOLUME, OF BENZENE AND 80 PER CENT OF TRICHLORETHYLENE. (MIXTURE II.)

Fraction	Temperature (Deg. C.)	Specific Gravity at 25 Deg. C.	Proportion of Components (by Volume) Benzene	Trichlorethylene
1	76	1.320	24	76
2	85.5	1.324	23.1	76.9
3	86	1.328	22.4	77.6
4	86.3	1.330	22.1	77.9
5	86.3	1.333	21.6	78.4
6	86.5	1.335	21.2	78.8
7	89.5	1.340	20.3	79.7
8	90	1.347	19.2	80.8
9	92.5	1.355	17.8	82.2
10*	88	1.367	15.7	84.3

Specific gravity of mixture before distilling, 1.342.
Specific gravity of all fractions mixed, 1.341.
Time of distillation, 1 hour, 12 minutes.
* About 6 c.c. remained in the flask (consisting of 93 3 per cent of trichlorethylene).

In the case of the mixture in Table IV the maximum percentage of benzene is in the first fraction, which was found on testing, however, to be non-flammable. Mixture II can therefore be distilled by direct heat with safety.

TABLE V—RESULTS OF DIRECT DISTILLATION OF 500 C.C. OF A MIXTURE OF 35 PER CENT, BY VOLUME, OF GASOLINE AND 65 PER CENT OF CARBON TETRACHLORIDE. (MIXTURE III.)

Fraction	Temperature (Deg. C.)	Specific Gravity at 25 Deg. C.	Proportion of Components (by Volume) Gasoline	Carbon Tetrachloride
1	40	1.353	26	74
2	78	1.379	23.9	76.1
3	79	1.390	22.6	77.4
4	80	1.391	22.5	77.5
5	81	1.395	22	78
6	82	1.393	22.3	77.7
7	82	1.341	28.3	71.7
8	89	1.285	34.8	65.2
9	98	.938	75.1	24.9
10*	....	.....	....	....

Specific gravity of mixture before distilling, 1.283.
* Last fraction, apparently all gasoline, remained in flask.

It is evident at once from the data of Table V that gasoline cannot be used with carbon tetrachloride without fractionating toward the end of the distillation into practically pure gasoline, which would introduce an element of danger. This is, of course, to be expected from the wide range of temperature at which the gasoline boils. A similar mixture was distilled under reduced pressure, but in this case also the last two fractions were flammable. It follows for the same reason that gasoline could not be used with trichlorethylene.

Steam Distillation of the Solvent Mixtures

Since solvent recovery in a commercial extraction plant is accomplished to a great extent by means of steam distillation, mixtures I and II were subjected to such a distillation, with the results tabulated in Table VI.

A comparison of the results in Table VI with those obtained with direct distillation reveals the fact that a slightly greater fractionation takes place in both mixtures with steam distillation. This slight difference, however, is sufficient to make mixture II unsafe when the solvent mixture is recovered with a current of steam, since the first fraction thus obtained is flammable. The final fraction in mixture I is of doubtful safety according to the test, its proportion of benzene being a trifle too high to make such a mixture entirely safe when steam is used for its recovery. For commercial operation it would be advisable to choose a mixture with a slightly lower percentage of benzene. For instance, 28 per cent by volume of benzene and 72 per cent of carbon tetrachloride would be within the limit of safety. For mixture II a proportion of 17 per cent by volume of benzene and 83 per cent of trichlorethylene should be feasible.

TABLE VI—RESULTS OF STEAM DISTILLATION OF 500 C.C. EACH OF MIXTURES I AND II

	Mixture I — 30 Per Cent Benzene and 70 Per Cent Carbon Tetrachloride, by Volume				Mixture II — 20 Per Cent Benzene and 80 Per Cent Trichlorethylene, by Volume			
Fraction	Temp., Deg. C.	Sp. gr. at 25 Deg. C.	Benzene	Carbon Tetrachloride	Temp., Deg. C.	Sp.gr. at 25 Deg. C.	Benzene	Trichlorethylene
1*	40	1.387	28	72	45	1.308	25.6	74.4
2	68.5	1.384	28.3	71.7	72	1.315	24.5	75.5
3	68.5	1.382	28.6	71.4	72	1.323	23.2	76.8
4	68.5	1.380	28.9	71.1	74	1.326	23	77
5	68.5	1.377	29.3	70.7	75.5	1.331	22	78
6	69	1.375	29.6	70.4	77	1.335	21	79
7	70	1.371	30.1	69.9	79	1.344	19.7	80.7
8	71	1.365	31	69	79	1.349	19	81
9	73	1.356	32.3	67.7	79	1.359	18	82
10†	74–105	1.318	38	62	80–105	1.367	16	84

* Fraction 1 in mixture II is flammable.
† Fraction 10 in mixture I is of doubtful safety.

Distillation of Cottonseed Extract

In commercial operations the solvents must be recovered from the extracted oil and from the residues. Since the presence of nitrogenous and albuminous materials in the solvent extract frequently causes foaming, conditions are naturally somewhat different from those obtaining when the solvents alone are being recovered, as in the foregoing experiments. Consequently, in order to simulate plant conditions cottonseed extracts were made with a mixture of benzene and carbon tetrachloride in the ratio of 30 to 70 and with a mixture of benzene and trichlorethylene in the ratio of 17 to 83, and the solvent mixtures recovered. These extracts contained approximately 20 per cent of oil besides the usual impurities extracted by organic solvents from such seed. The distillations were started by direct heat from a steam bath and when the concentration of the extract became such as to slow up the process a current of steam was admitted and the recovery of the solvent completed. The results of this experiment are recorded in Table VII.

From these results it may be concluded that the presence of extraneous matter extracted with the oil from cotton seed does not noticeably affect the extent of the fractionation and will not result in the production of flammable solvent vapors if the proper mixture is used. It is further evident, as concluded from Table VI, that in order to provide a somewhat greater margin of safety the proportion of benzene in mixture I must be reduced from 30 to 28 per cent by volume.

In connection with the use of such mixtures as have been discussed consideration must be given to the possibility of mixtures of vapors separating according to their density. If in the course of recovery or storing such mixtures quantities of vapors should escape and remain for some time in a closed room, there is a possibility that the carbon tetrachloride vapors would settle toward the floor, thus leaving an upper stratum of flammable benzene vapors. In a mixture of vapors, however, the force of diffusion and the force of gravity are operating against each other. An attempt was made to obtain some data on this point by volatilizing several hundred cubic centimeters of mixture I in a large ash can about 3 ft. high and 14 in. in diameter and carefully sealed. After 12 hours, samples of the vapors remaining uncondensed were drawn from the top and from the bottom of the can and tested. No great difference could be discovered. Three wide-mouthed liter bottles were filled with vapors from the top of the can, pure benzene vapors and ordinary air respectively. Lighted tapers were then inserted into each bottle. The bottle containing benzene was immediately filled with flame, while the two other tapers acted very much alike except that the one in the bottle containing only air burned somewhat longer. If these results are at all indicative of what would take place on a large scale it would not seem likely that a condition such as described would result in a serious fire risk.

TABLE VII—RESULTS OF DISTILLING 500 C.C. OF COTTONSEED EXTRACTS MADE WITH MIXTURES OF BENZENE AND CARBON TETRACHLORIDE AND BENZENE AND TRICHLORETHYLENE

	Proportion of Components (by Volume)			
	Mixture I — 30 Per Cent Benzene, 70 Per Cent Carbon Tetrachloride		Mixture II — 17 Per Cent Benzene, 83 Per Cent Trichlorethylene	
Fraction	Benzene	Carbon Tetrachloride	Benzene	Trichlorethylene
1	29	71	19.7	80.3
2	29	71	18.7	81.3
3*	30	70	18	82
4	30	70	17.3	82.7
5	30.1	69.9	17	83
6	30.3	69.7	16.5	83.5
7	30.7	69.3	16	84
8	31.3	68.7	15	85
9	32.6	67.4	13.7	86.3
10†	36	64	13.5	86.5

Fraction 1 of mixture II was non-flammable.
Fraction 10 of mixture I was of doubtful safety.
Fraction 10 of both mixtures was not full 50 c.c. in volume.
* Beginning with this fraction steam was admitted in distilling mixture II.
† Beginning with this fraction steam was admitted in distilling mixture I.

Economic Considerations

In estimating the approximate economy that may be effected by the use of such mixtures of solvents as have been described consideration will be limited to the two factors, fire risk and cost of solvent.

The technical objection to the chlorinated hydrocarbons—namely, that they have a tendency to

decompose slightly in the presence of steam with the formation of hydrochloric acid, which injures the equipment, will not be discussed here. As to the quality of the oils produced by the use of the several solvents under discussion, it is not believed that there is sufficient difference in their action to be a controlling factor. The cost of carbon tetrachloride and trichlorethylene fluctuates considerably, but their cost as a rule is at least four and one-half times that of benzene. Assuming that benzene costs 30c. a gallon and the carbon tetrachloride and trichlorethylene $1.35 a gallon, the comparative costs of 1,000 gal. of the several solvents and mixtures I and II would be as indicated in Table VIII.

TABLE VIII—COMPARATIVE COST OF 1,000 GAL. OF BENZENE, CARBON TETRACHLORIDE (OR TRICHLORETHYLENE), AND MIXTURES I AND II

Solvent	Cost Per Gal.	Cost Per 1,000 Gal.	Amount Saved on 1,000 Gal. as Compared With Pure Carbon Tetrachloride or Trichlorethylene
Benzene	$0.30	$300	.....
Carbon tetrachloride or trichlorethylene	1.35	1,350	.....
Mixture I: Benzene 28 per cent Carbon tetrachloride 72 per cent	1.06	1,056	$294
Mixture II: Benzene 17 per cent Trichlorethylene 83 per cent	1.16	1,161.50	$188.50

As indicated in the table, the saving on 1,000 gal. of mixture I over a similar quantity of pure carbon tetrachloride is $294, and that on 1,000 gal. of mixture II over pure trichlorethylene is $188.50. From another viewpoint it may be said that it costs the difference between $1,056 and $300, or $756 per 1,000 gal., to eliminate the fire risk by using mixture I, while by the substitution of pure carbon tetrachloride for benzene it will cost the difference between $1,350 and $300, or $1,050, to attain this end. In the same way the cost of eliminating the fire risk with mixture II amounts to $1,161.50 less $300, or $861.50. The cost of the fire hazard as reflected in insurance rates is difficult to estimate, but it should be easy to determine for each extraction plant whether such mixtures could be economically used provided there are no other objections to the employment of carbon tetrachloride or trichlorethylene as solvents.

Conclusions

The use of such flammable solvents as benzene and gasoline in the extraction of vegetable oils has the great advantage of low cost per gallon over the non-flammable solvents carbon tetrachloride, trichlorethylene and other members of the chlorinated hydrocarbons. However, even with carefully constructed equipment and all possible safeguards the fire risk is naturally considered by insurance underwriters to warrant a much higher rate of insurance on such a plant if flammable solvents are used than is otherwise the case. A mixture of the two types of solvents in such proportion that the mixture or its vapors are at all times non-flammable would reduce the original cost below that of the high-priced non-flammable solvent and at the same time eliminate the high insurance rates.

It was found by experiment that a mixture of benzene and carbon tetrachloride in the ratio of 30 to 70 per cent by volume, a mixture of benzene and trichlorethylene in the ratio of 20 to 80 per cent by volume and a mixture of gasoline and carbon tetrachloride in the ratio of 35 to 65 per cent by volume are non-flammable to the extent that their vapors cannot be exploded or set afire by an electric spark.

These mixtures when distilled by direct heat or by a current of steam fractionate to a certain extent. The mixture containing gasoline becomes entirely unsafe. The benzene mixtures fractionate much less, that containing trichlorethylene producing a flammable fraction at the start of the distillation and that containing carbon tetrachloride producing at the end a fraction which is so nearly flammable that its use would be risky.

Mixtures entirely safe when recovered by means of either steam or direct distillation from extracted oil and at the same time containing the maximum amount of the cheaper component benzene would consist of (1) benzene 28 per cent and carbon tetrachloride 72 per cent by volume, (2) benzene 17 per cent and trichlorethylene 83 per cent by volume.

The comparative cost per gallon of the three pure solvents and of mixtures I and II indicates that the use of the latter as a means of eliminating fire risk can be effected much more economically than by the use of either of the pure non-flammable solvents.

Bureau of Plant Industry,
U. S. Department of Agriculture,
Washington, D. C.

Air Lift Supplies Cold Water for Tire Manufacture

By Ralph T. Stone

THE Denman-Myers Cord Tire Co. recently constructed a plant near Warren, Ohio, for the exclusive manufacture of cord tires. The Osborn Engineering Co. of Cleveland, Ohio, was the engineer and contractor and the equipment for producing 1,000 tires per day was installed in record time. The layout involves several distinctive features, chief of which is the use of Sullivan air lifts for delivering water from the artesian wells on the property. Large quantities of water of even temperature are required. Water from these deep wells is of constant temperature, 55 deg. F., the year around. It was realized that if the well water were pumped to a storage reservoir or tank, it would become warm in summer and the greater part of the advantage of cold water would be lost. An ingenious arrangement was devised to distribute the cold water from one of the wells direct to the plant and maintain constant pressure on the mains without the use of a storage tank. Two wells about 160 ft.

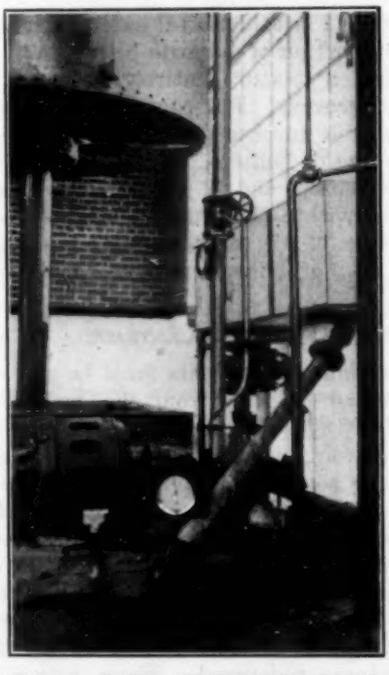


FIG. 1—VIEW IN ENGINE ROOM, SHOWING WELL NO. 1 WITH CENTRIFUGAL PUMP, COLLECTING TANK AND FLOAT-OPERATED AIR VALVE

deep and 8 in. in diameter were found to supply ample water. Well No. 1, Fig. 1, is located below the power house and Well No. 2 about 250 ft. north of the power house. Well No. 2 is equipped with a 3-in. Sullivan standard air life pump and a 24 x 24-in. booster-separator. The discharge from this well is delivered through a horizontal pipe 182 ft. long into the storage reservoir at 6 ft. elevation above the well head, as shown in Fig. 2. The booster, which is placed in the small house at the head of the well, separates the air from the water and discharges the water in a steady stream as shown.

The water from Well No. 1 is not discharged into the reservoir, but is distributed direct through the plant and furnishes a splendid supply of cold water for drinking fountains, lavatories and the mills and calenders. The low temperature of the water used in the mills and calenders greatly increases their capacity and improves the quality of the product.

Well No. 1 comes up through the floor in the engine room as shown in Fig. 1. It is equipped with a 3-in. Sullivan standard air lift pump and the water is discharged through the inclined pipe into the collector tank attached to the wall. The eduction pipe from the

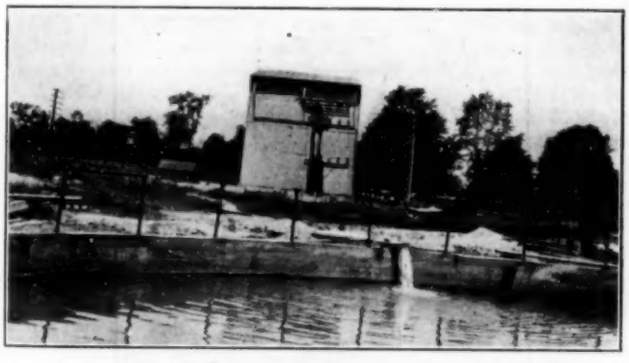


FIG. 2—DISCHARGE FROM WELL NO. 2, SHOWING RESERVOIR AND SMALL HOUSE CONTAINING BOOSTER IN THE BACKGROUND

well comes up through the bottom of the tank above the water level and is fitted with an umbrella separator to control the discharge and prevent splashing. The air line to the well passes over a corner of the collector tank and is equipped with a float-operated valve which is very sensitive in operation. This valve keeps the water at constant level in the collector tank and prevents overflowing.

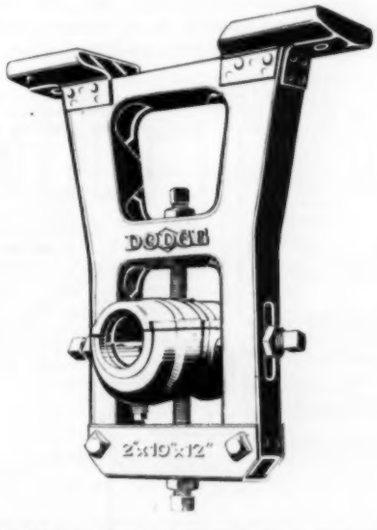
The suction of the centrifugal pump is connected to the bottom of the collector tank as shown in Fig. 1, and since it is below the water level in the tank, the pump is always primed. This pump runs continuously and maintains a constant discharge head of 90 lb. Advantage is taken of the well-known fact that a centrifugal pump maintains fairly constant pressure, independent of the quantity of water handled. The water is used all over the plant and the quantity drawn varies considerably, depending upon the number of spigots and valves which may be opened at any one time. Every valve in the distributing system may be closed at the same time without affecting conditions at the pump. In order to prevent heating of the pump when no water is being used, a ¾-in. pipe is tapped into the discharge line close to the pump and led back to the top of the collector tank as shown in the illustration. This pipe is provided with an ordinary globe valve which is kept slightly open, permitting a small stream of water to flow back into the collector tank. The apparatus has been in continuous operation since Oct. 1, 1920, and has required little attention. The plant has enjoyed an ample supply of water at all times and has been entirely free from shutdowns due to shortage of water.

Air System

Compressed air for the wells and for several manufacturing purposes is supplied by a Sullivan Class "WA-6" center crank, straight line steam-driven air compressor. This machine has a 9 x 10-in. single steam cylinder, and an 11 x 10-in. single stage air cylinder. a capacity of 258 cu.ft. of free air per minute. The air compressor is provided with a governor which automatically slows down the machine to deliver the exact quantity of air needed. The air requirements vary and most of the time the machine is run at moderate speed. An unloader is provided on the air cylinder which pletely unloads the compressor when no air is being used and permits the machine to run idle with the consumption of very little steam. Adjustment is provided on the governor which makes it impossible for the compressor to stall when running at minimum speed. The amount of air required to pump the wells, for the water supply thus far needed, is so small as to be scarcely noticeable in the load carried by the air compressor. Some of the other purposes for which the compressed air supplied by the compressor decribed above is employed include removing inner tubes from the mandrel on which they are made; holding the tires in the metal molds by means of a "bag" filled with compressed air; cleaning the molds by means of sand blasts and a gas flame under air pressure.

A New Pressed Steel Lineshaft Hanger

The accompanying illustration shows a pressed steel hanger for general purpose use, developed by the Dodge Sales & Engineering Co. of Mishawaka, Ind. This hanger is designed to meet the need for a lineshaft



hanger of lightness and strength to serve under conditions not severe or unusual and where first cost is of guiding importance. It is not believed that steel hangers are suitable for every purpose regardless of their construction, but this type seems to be quite practical under conditions which permit its use and where extreme vibration is not a factor.

Recent Chemical & Metallurgical Patents

American Patents

Complete specifications of any United States patent may be obtained by remitting 10c. to the Commissioner of Patents, Washington, D. C.

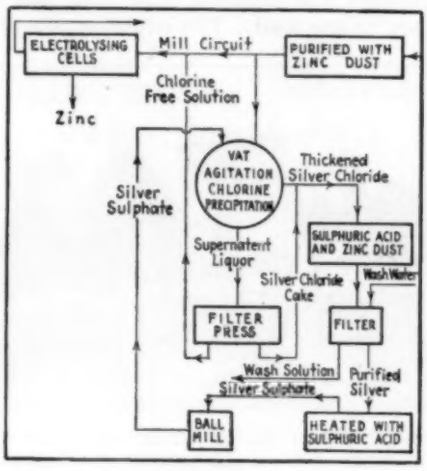
Anhydrous Aluminum Chloride.—The specification covers the production of aluminum chloride by suspending aluminum carbide, ground to 200 mesh, in hydrochloric acid gas and passing the mixture into a brick-lined reaction chamber wherein the application of heat brings about the reaction resulting in the formation of aluminum chloride. The reaction chamber is provided with a pair of arc electrodes which supply the heat necessary to start the reaction. The volatile anhydrous aluminum chloride passes into a series of condensers fitted with baffle plates, wherein it is deposited in powdered form. Once the operation is established, the arc is discontinued, the reaction proceeding exothermically. (1,405,183. Louis Burgess, New York, assignor to Standard Oil Co. of New Jersey. Jan. 31, 1922.)

Recovery of Zinc and Copper From Brass Scrap.—Oliver C. Ralston, of Niagara Falls, N. Y., dissolves brass in chlorine water, $CuCl_2$ solution, or HCl and oxygen. If this is properly done, the zinc and copper both enter solution as chlorides. The solution; heated to 100 deg. C. is passed through a ball mill charged with a further amount of brass scrap, whereupon preferential solution occurs, the zinc passing into solution, leaving behind or reprecipitating metallic copper, and reducing soluble cupric chloride to insoluble cuprous chloride. Zinc chloride solutions resulting from this operation may be filtered, purified and electrolyzed for zinc, the chlorine also being recovered for re-use as a solvent. Cuprous chloride may also be converted into various useful salts or metallic copper. (1,402,015; assigned to Hooker Electrochemical Co. Jan. 3, 1922.)

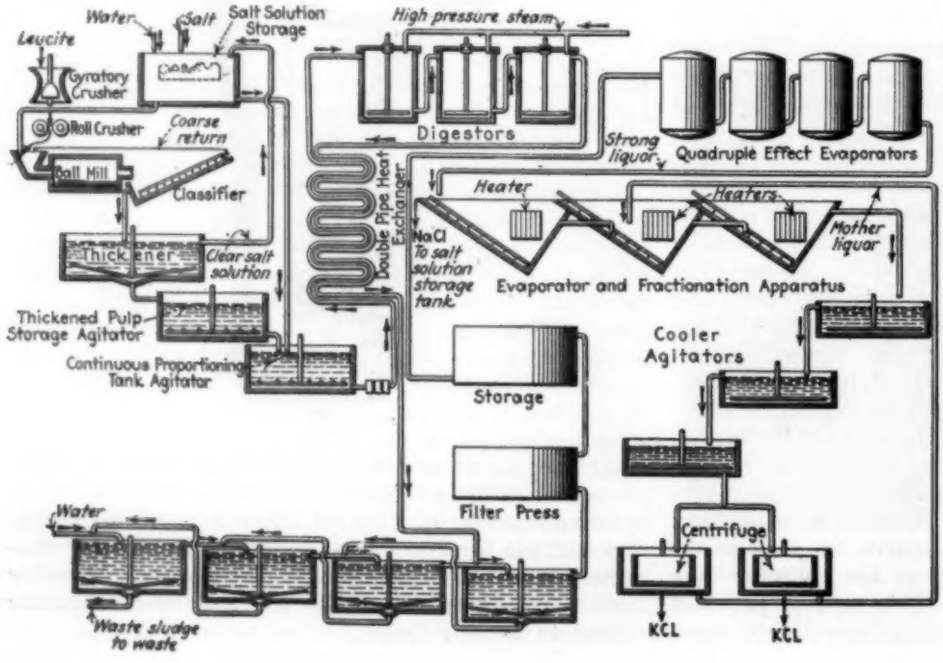
Production of Potassium Chloride.—A continuous wet process for the recovery of potash from leucite (or a similar mineral containing a double silicate of aluminum and potassium) is based on the wet grinding of the mineral in a solution of common salt. After crushing the mineral to a suitable size and grinding it with the salt solution, the sludge is thickened and passed to a storage tank, where it is continually agitated to prevent settling. It is then passed to the proportioning tank, where salt solution is added in excess of that required to substitute the sodium for the potassium in the mineral. Thence the mixture is fed to a group of digestors subjected to high steam pressure and is raised to the temperature and pressure required for completing the chemical reaction. By fractional evaporation or otherwise the solid sodium chloride and solid potassium chloride are removed from the strong liquor, the former being returned for further use in the process, and the latter passed to a series of agitators which it traverses in series. From these coolers the crystallized KCl and mother liquor is run to a centrifuge from which the dried product is ready for shipment. The mother liquor in whole or in part is returned to the evaporating apparatus. The details of the procedure can be more easily understood if reference is made to the accompanying drawing. In this diagram no attempt is made to show the pumps which must be employed at different places in the system.

The inventor claims that 80 to 90 per cent of the potash in the mineral is replaced by the sodium providing proper conditions of concentration, temperature and pressure are maintained. (1,402,973; Mark Shoeld of Chicago, Ill., assignor to Armour Fertilizer Works. Jan. 10, 1922.)

Electrolytic Zinc.—David Avery and R. H. Stevens, of Australia, have patented a method of eliminating chlorine



from zinc sulphate electrolytes, believing it the principal cause of disintegration of the lead anodes and aluminum cathodes ordinarily used in the process. (If glue is used in the process, as much as 50 mg. Cl per liter may be tolerated.) Chlorine is kept below the danger point by bleeding a certain quantity of the circulating mill solutions, after they have been purified with zinc dust. It is then made slightly acid with H_2SO_4, and finely powdered Ag_2SO_4 added to reduce (by precipitation of AgCl) the soluble chlorine to 2 or 3 mg. Cl per liter. Agitation for 1 hour is required to complete the reaction, the solution then neutralized and the precipitate coagulated by adding electrolyte. After settling, the clear solution is filtered, treated with a small amount of zinc dust, refiltered, and returned to the circuit. Methods are also outlined for the complete recovery of the silver reagent, as summarized in the diagram printed above, and consisting essentially of reduction by zinc. (1,403,065; assigned to Electrolytic Zinc Co. of Australasia Proprietary, Ltd., Jan. 10, 1922.)



Technical News of the Week

Current Events in the Chemical, Metallurgical and Allied Industrial Fields—Legislative Developments—Activities of Government Bureaus, Technical Societies and Trade Associations

Program of American Chemical Society Meeting Announced—Muscle Shoals Trip Canceled

With the appearance of the complete program for the spring meeting of the American Chemical Society at Birmingham, Ala., April 3 to 7 inclusive, preliminary preparations are brought to a point where an interesting session is assured. Monday, the first day of the meeting, will be devoted to a Council meeting and the Councilors' dinner at the Southern Club. Tuesday will be occupied by two general meetings and a smoker in the evening. Wednesday and Thursday will be given over to the meetings of the various divisions, all of which have arranged programs of papers except the Leather and Fertilizer Divisions. Excursions to the steel, acid, cement and other industries in the Birmingham district are planned for Friday.

The proposed side trip to Kingsport, Chattanooga and Muscle Shoals has been abandoned. The running of the special train was contingent upon 125 guaranteed fares, and since the total number of applications received up to March 20 fell short of that number, the project was dropped. As a result there will be no provision made for those attending the meeting to visit Muscle Shoals in a body.

A rate of one and one-half fare for the round trip has been granted, good from all parts of the United States except west of Utah. This reduction is contingent upon the attendance of not less than 350 members. In order to take advantage of this reduced rate, members must obtain certificates at the ticket office where the one-way ticket to Birmingham is purchased.

The general meetings will be held in the Auditorium of the Hotel Tutwiler. The divisional meetings will be held at the Hotel Tutwiler or the Southern Club unless otherwise announced. The final program is as follows:

Monday, April 3

4 p.m.—Council meeting. Southern Club.

6:30 p.m.—Dinner to the Council at the Southern Club.

Tuesday, April 4

10 a.m.—General meeting, Auditorium, Hotel Tutwiler.

Address of welcome, Nathan L. Miller, Lieutenant-Governor of Alabama.

Response, Edgar F. Smith, president, American Chemical Society.

Carlile P. Winslow, director, U. S. Forest Products Laboratory, "The Development of the Forest Products Industry in the South."

William H. Stone, associate editor, *Manufacturers Record*, "The Remarkable Development of the South and Its Relations to the American Chemical Industry."

2 p.m.—General meeting, Auditorium, Hotel Tutwiler.

Theodore Swann, "The Manufacture of Phosphoric Acid in the Electric Furnace by the Condensation and Electrical Precipitation Method."

Van H. Manning, "The Pioneer's Field in Petroleum Research."

Charles L. Reese, "Information Needs in Science and Technology."

W. C. Geer, "Recent Developments of the Chemistry of Rubber."

W. D. Bigelow, "Some Research Problems in the Canning Industry."

Francis P. Venable, "Chemistry in the Old South and the New."

8 p.m.—Smoker as guests of the Alabama Technical Association at the Southern Club.

Wednesday, April 5

9:30 a.m.—Divisional meetings, Tutwiler Hotel and Southern Club (see divisional programs).

2 p.m.—Divisional meetings continued.

8 p.m.—Public meeting, Southern Club ball room. Public address. People of Birmingham, especially ladies, invited. Marston Taylor Bogert, past president, American Chemical Society, "The Flower Fields and the Organic Chemist: Perfumes—Natural and Synthetic."

Thursday, April 6

9:30 a.m.—Divisional meetings, Tutwiler Hotel and Southern Club (see divisional programs).

2 p.m.—Divisional meetings continued.

4 p.m.—Meeting of chairmen and secretaries of local sections, Tutwiler Hotel.

7 p.m.—Banquet, Tutwiler Hotel.

Friday, April 7, and Saturday, April 8

Excursions.—There will be an excursion by special train, on Friday, to the blast furnaces, steel plants, coke ovens, mines, etc., of the Tennessee Coal & Iron Co. A barbecue dinner will be served in Southern style at 1 p.m., at Bayview Mines. The train will traverse the famous Red Mountain, which will afford an inspiring view of the industrial district.

Arrangements have also been made for individual or small party trips on Saturday to the various industrial plants in the city, such as sulphuric acid, fertilizer, slag and portland cement, cottonseed oil and filtration plants, where members may desire to go. Detailed information of this will be supplied at the registration desk. Automobiles will be furnished for this trip.

Divisional Meetings

The following divisions and sections will meet on the days noted:

Division of Agricultural and Food Chemistry, Thursday: 21 papers to be presented.

Division of Physical and Inorganic Chemistry, Wednesday and Thursday: 26 papers to be presented.

Section of Chemical Education, Wednesday and Thursday: 19 papers to be presented and a round table discussion on chemical engineering education.

Section of History of Chemistry, Thursday: 11 papers are to be presented, several of which will be supplemented by exhibits of rare books, autograph letters, documents and apparatus.

Division of Organic Chemistry, Wednesday and Thursday: 34 papers.

Division of Rubber Chemistry, Wednesday: 7 papers.

Division of Industrial and Engineering Chemistry, Wednesday and Thursday: 23 papers. This list includes 8 papers constituting a symposium on distillation.

Section of Cellulose Chemistry, Wednesday and Thursday: 18 papers.

Section of Sugar Chemistry, Wednesday and Thursday: 18 papers.

Division of Dye Chemistry, Thursday: 12 papers.

Division of Biological Chemistry, Thursday: 14 papers.

Section of Petroleum Chemistry, Wednesday: 11 papers.

Division of Water, Sewage and Sanitation, Thursday: 8 papers.

Would Shorten Term of Patent Protection

Under a bill introduced by Senator Ladd, of North Dakota, a patent would expire within 5 years after its issuance unless the patentee exercised the right to make or use the invention or discovery. In event of the assignment of the patent, the patent rights would extend only for 2 years if not worked.

Dye Monopoly Charges Begin to Look Ridiculous as Additional Testimony Refutes King Charges

Senator King of Utah, chief accuser of domestic chemical enterprises before the Senate investigating committee, very evidently is beginning to think better of the industry. That he has been embarrassed in no slight degree by the failure of his informants to justify the charges which he has voiced is very apparent. No one questions that Senator King was thoroughly convinced that all of his charges could be proved. On these fundamentals he built great superstructures, which now appear to be edifices of cards. The Utah Senator cannot hide his chagrin as one by one his charges are controverted to the seeming satisfaction of the investigating committee. Senator King's part was well done, but his mysterious informants—who were so ready to make charges—appear to be unable to substantiate any one of them. This does not mean that Senator King is convinced that the chemical industry has been conducted in an entirely flawless manner, but it is the very general impression that he has revised his opinion of the industry.

One of the outstanding developments of the week was the very convincing showing made before the committee by the Chemical Warfare Service. General Fries was not only able to refute entirely the charges which have been made against his organization, but was able to say some things about the organic chemical industry which carried more weight than if they had come from representatives of the industry.

Not the least interesting high light in the week's hearings was the testimony of H. A. Metz, who attacked the embargo from the standpoint of the importer. Mr. Metz was caustic in his comments as to the criticisms passed upon his actions by Francis P. Garvan and others, accusing him of being a German agent and insinuating that he was party to German propaganda. When Mr. Garvan interjected a remark during his account of his tariff activities, Mr. Metz flashed back, "Don't try and tell me anything about the dye business, Mr. Garvan. I've been in it 40 years and you've been in it 15 minutes."

The testimony of representatives of the manufacturers was concluded on Saturday, March 18. Joseph H. Choate, Jr., counsel for the American Dyes Institute, informed Senator Shortridge at that time that the manufacturers felt they has made their position clear and would rest their case unless it developed that the testimony of Mr. Metz made necessary the recall of some of the witnesses.

Metz Defends His Record

An extended statement in defense of his views in opposition to the embargo on dyestuffs and in reply to charges alleging a persistent effort in the interest of the German dye monopoly on his part was read into the record by Herman A. Metz of New York, importer and manufacturer of dyes and pharmaceutical products. He stated that there was no doubt that Germany had a monopoly on the organic chemical industry before the war, not because she had a monopoly on the raw materials but because of the excellence of the products. When the war broke out in 1914, Mr. Metz said, he realized the serious effect that the German embargo would have on consumers in the United States and he immediately took steps to have the embargo lifted as far as America was concerned, in order that this country might continue to receive the drugs and dyestuffs that it needed. He pointed out that he had used his best efforts to establish the manufacture of salvarsan and novocain in this country and had succeeded in producing products equal in quality to the German. "What possible basis can there be for charging me with having subserved the purposes of Germany when after 1914 I did what I always have done—assisted in the import of dyes and pharmaceuticals from the only country from which they could be obtained?" he asked.

Mr. Metz sketched the history of the importers of dyes in this country from the time when he entered the employ of an importer as office boy, 40 years ago. He touched upon his own political career and his activities as an importer and a manufacturer during the war and his litigation with the Alien Property Custodian.

The witness said that much "pure bunk" had been distributed from the Department of Commerce and other sources concerning the ability of American manufacturers to make dyes and the quality of the dyes. The trouble with the American manufacturers is that the Americans "don't know what their colors will do and the mills don't know what they want."

In reply to questions from Senator Sterling, the witness stated that he did not believe American manufacturers would ever make the high-grade dyes not made here today, because the cost would be out of proportion to the demand for them. The Germans could, he continued, because they once had the world market, but the American market is only 10 per cent of the world market.

Going into the question of salvarsan, Mr. Metz stated that the American-made product was superior to the German, but that some physicians and patients demanded the latter. Much of the German product is now being smuggled in, he told the committee. "That's the basis of my objection to the licensing system," he went on. "A man should be allowed to get what he wants if he is willing to pay for it."

Mr. Metz then went into the story of his troubles with the Alien Property Custodian. He related that Joseph H. Choate, Jr., then connected with the Alien Property Custodian, suggested that he consent to an examination of his property, the expense, to be reasonable, to be paid for by him. The Alien Property Custodian was then seeking to trace German-owned property. He agreed, but the investigation continued 5 months and the cost was $30,000. He felt that this occurrence made "highway robbery an amateur sport by comparison."

Grasselli Company Claims to Be Losing on $4,500,000 Dye Investment

The Grasselli Co. will discontinue the manufacture of dyes unless proper protection is given against foreign competition, according to statements in the testimony of William T. Cashman, vice-president of the company. The Grasselli Co. went into the dye business with much hesitation, Mr. Cashman said, knowing the difficulties ahead of it. The total invested capital of the company is $50,000,000, of which $4,500,000 is invested in the dye business. It has not put any additional capital into the business for the past year or two because of the uncertainty as to whether Congress will support the industry with protective legislation. The witness declared that keen competition exists among American dye producers, citing as examples his company's experience with Wool Green S and nigrosene.

Tariff Not Sufficient Protection

No tariff could be written to cover the American dye and organic chemical industry, testified George H. Whaley, principal owner of John Campbell & Co., New York City; the Amalgamated Dyestuffs & Chemical Works, Newark, N. J., and the Republic Color & Chemical Works, Reading, Pa. Time for research is the chief essential for development of the industry, he continued. "That time we cannot gain unless the Germans are prohibited from shipping into this country dyestuffs made here."

Emphasizes Relation of Industry to Education

Harrison E. Howe, formerly of the National Research Council, stated his belief that all chemical education and research work in the future in American universities, colleges and schools must depend upon the existence and development of a domestic dye and organic chemical industry.

"It would be futile to endow chemical education without the industry," he declared, "for the industry supports education. The industry provides opportunity for necessary research work and also provides careers for the graduate chemists of our institutions."

Dr. Howe told of the purposes of the National Research Council, which dates from the Civil War, explaining that its overhead expenses are paid from the income of a $5,000,000 endowment from the Carnegie Foundation. He said that the first suggestion of an exhibit concerning the dye and organic chemical industry came from Dr. Julius Stieglitz,

a University of Chicago professor without commercial connections with the industry. The Chemical Warfare Service obtained permission to co-operate in the exhibit as a commendable educational step. After some difficulty, he continued, the American Dyes Institute and the Chemical Foundation were persuaded to bear part of the cost. In addition, some contributions were received from individuals in the dye industry.

Value of Industry in Case of War Emergency

The testimony of Dr. Howe in regard to the exhibit was corroborated by Brigadier-General Amos A. Fries, chief of the Chemical Warfare Service, who testified that the exhibits were prepared without having in mind any special group of interests or legislation. At the beginning of the war, he said, America was without an organic chemical industry and consequently without chemical weapons. It was 11 months after the Germans began the use of poison gas before the Allies were able to retaliate but in the mean time there had been 350,000 Allied casualties from poison gas.

In answer to questions from the chairman, General Fries said that neither Francis P. Garvan, president of the Chemical Foundation, or any of its representatives ever sought to influence him to support any particular legislation, but he saw from his own experience in France the need of an organic chemical industry in this country and the need for its protection during development.

Small Manufacturers Add Voice to Denial of Monopoly Charges

Samuel Isermann, president of the Chemical Company of America and secretary-treasurer of Van Dyck & Co., of New York and New Jersey, appeared before the committee as the representative of more than forty small chemical manufacturers throughout the country. Dr. Isermann declared that the charges that had been made against the American industry were made with the idea of discrediting the entire organic chemical industry in the United States.

"We invite cross-examination by Senator King and Senator Moses," he added. "I challenge either of the Senators or anyone else to prove a monopoly exists. It simply cannot be done, and they know it. That is why they are not here. They know they cannot prove their loosely made charges by which they sought to damn this vitally important industry."

Dr. Isermann sketched briefly his own experiences as a manufacturer and his efforts on behalf of the small manufacturer to obtain legislative protection. He also read into the record extracts from a speech made on the floor of the house on July 9, 1921, by Representative Layton of Delaware, a practicing physician. Mr. Layton spoke in advocacy of the chemical schedule, pointing out the importance of the organic chemical industry in the prevention and curing of disease and for purposes of defence in time of war. Dr. Isermann also quoted from a speech made by Herman A. Metz in 1910, in which he showed very clearly that there was no organic chemical industry in the United States at that time. Practically all of the fine chemicals that were produced in this country were made by simple combination of highly refined foreign intermediates or by the purification of imported crude material.

Not the least interesting part of Dr. Isermann's testimony was his specific references to a number of cases where the German producers of fine chemicals and pharmaceuticals were able to charge outrageously high prices for their products until their patents expired or until forced down by boycotts. Ionone, for example, sold as high as $1,100 a pound in 1904, when the witness stated that he undertook the manufacture of the substance on a small scale. He was able to sell it with a profit at $75 a pound. Synthetic musk, which was introduced into the United States in 1899, sold at $1,600 per pound. As the time of expiration of the patent drew near, the price was reduced until it sold at about $20 a pound. Just before the war the price was down to $2. Numerous other specific synthetic preparations were mentioned by the witness in support of his contention that reasonable treatment could not be expected in the future at the hands of the German Cartel.

Industrial Developments of the Week

Glass. — The Wilcox-Durand Co., Newfield, N. J., has resumed operations at its local glass-manufacturing plant, following a period of curtailment. Orders on hand insure production for some time to come.

The Cape May Glass Co., Cape May, N. J., manufacturer of bottles, etc., has resumed production at its plant, following a number of weeks' shut-down. A large force of glass blowers is being employed, and certain departments are on a double shift basis.

Rubber.—The Lee Tire & Rubber Co., Conshohocken, Pa., is operating on a capacity schedule at its local plant, manufacturing about 2,000 tires a day. The new plant addition is also running on the same basis. This is the first time that maximum output at both plants has prevailed.

Oil.—The Producers' Oil & Refining Co. has resumed operations at its refinery at Gainesville, Tex., following a shut-down for about a year. The plant gives employment to about 100 men and has a capacity of 15,000 bbl. daily.

The Corona Petroleum Co. has placed its refinery at Chijol, Vera Cruz, Mexico, in commission. The plant has a daily capacity of 37,000 bbl., and is the largest in the Tampico field.

Iron and Steel.—The Carnegie Steel Co. is arranging for the blowing in of the No. 3 blast furnace at its Isabella Works, Pittsburgh district, Pa. The unit has been down since last May. The company is operating at fourteen of its fifteen furnaces in the Youngstown district, Ohio.

The Bethlehem Steel Co., Bethlehem, Pa., has resumed operations at its Saucon, Pa., plant, after an idleness of a number of weeks.

During the first week in March about 300 men were added to the working forces of the Gary, Ind., steel plants, bringing the quota to about 15,000 men in the different departments, as compared with approximately 12,000 last December. Additions will continue, it is stated, on a basis of from 200 to 300 men weekly.

The Gulf States Steel Co., Birmingham, Ala., is now operating at 100 per cent in the blast-furnace department for the first time in a number of months. The finishing mill at the plant is running on a basis of about 300 carloads during March.

The Woodward Iron Co., Birmingham, Ala., has two blast furnaces in operation at its plant, and is considering the blowing in of a third stack at an early date.

Tin Plate.—The N. & G. Taylor Co., Cumberland, Md., is arranging for the immediate resumption of operations at the bar mill and open-hearth furnaces at its local tin plant. These departments have been closed down for about a year. The mills are now giving employment to about 400 men, and this number will be increased considerably with the resumption.

Coke.—The H. C. Frick Co., Uniontown, Pa., is firing additional ovens at its local plant.

During the week ended March 9 an addition of 640 ovens was added to the active producing list at the coke plants in the Connellsville, Pa., district. Since the first of the year over 2,000 additional ovens have been placed in service.

Miscellaneous.—The Glidden Co., Cleveland, Ohio, manufacturer of paints, varnishes, etc., has adopted an overtime schedule in certain departments at the plant, about two-thirds of the working force operating until 8 o'clock each night. A full working quota is being employed at the plant. The company is operating its lithopone plant at Baltimore, Md., at full capacity, and is said to have sufficient orders on hand to insure this basis for 12 months to come.

The Solvay Co. is operating its chemical plant at Detroit, Mich., at full capacity.

The Tennessee Copper Co., Chattanooga, Tenn., will increase production in its byproduct department, primarily for a greater output of sulphuric acid for a large order received from the Standard Oil Co., to be used in connection with petroleum refining.

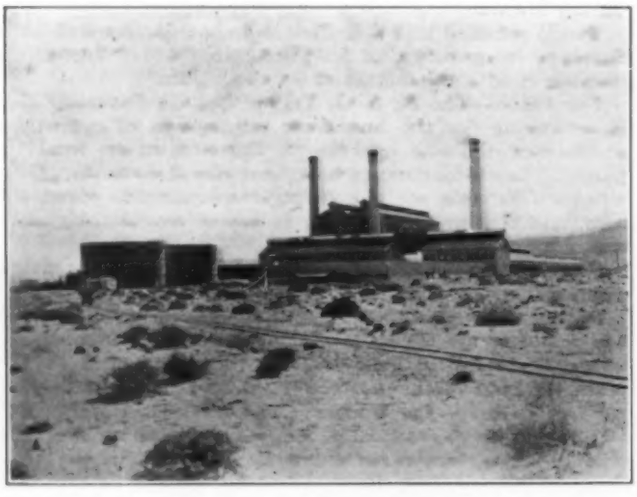
The Bethlehem Spark Plug Co., Bethlehem, Pa., will increase production at its plant. The company has taken an order for spark plugs for the Packard Motor Car Co., Detroit, Mich., requiring an output of about 250,000 plugs a year.

Potash Producers Ask Tariff Protection to Give American Industry a Fighting Chance

A number of points of interest in connection with the efforts of chemical industries established in America during the war to obtain adequate protection in the pending tariff legislation are brought out in the petition of forty-five American potash producers recently presented to Congress. The petition is drawn up in the form of a 43-page booklet, profusely illustrated, and presents, in popular style, a review of the development of the local potash industry under the stress of war-time needs. It also calls attention to the large amount of private capital which is tied up in potash enterprises throughout the country and which is yielding no return because the surplus of foreign potash that has been dumped on the market makes operation unprofitable.

The brief opens with a statement of the grievances of the American producers. It is pointed out that the German Government, through the Kali Syndikat, has to all intents and purposes destroyed property owned by American citizens to the extent of about $30,000,000. This attempt on the part of the German monopoly to regain its world-wide control of the potash market was predicted by German agents in 1917 when the basis of an American potash industry was being laid. It is also affirmed that German agents are now conducting an extensive propaganda in this country to mislead Congress and the public about the needs of the American potash industry to the end that it may be denied the protection it seeks from foreign aggression.

The development of local sources of potash on a commercial scale when the annual 200,000 tons which had been imported from Germany was cut off is described in the brief. The increase in production in America from 1,000 tons in 1915 to 54,000 tons in 1918 is traced, and then the decline until 1921 when the American plants were forced to shut down because of the selling at "cut rates" of enormous quantities of potash below the American cost of production. All of them are now shut down, and the carrying charges and the loss of interest are very heavy. The



POTASH WORKS OF TRONA CORPORATION AT SEARLES LAKE, CALIFORNIA

producers find now that they cannot sell a pound of potash on the American market at any price, owing to the terms of the German contracts with the fertilizer manufacturers.

The sources of supply which have been worked commercially are very widespread. Among the more promising may be mentioned the natural brines of the Nebraska lakes, Searles Lake, alunite, silicates and kelp, blast-furnace dust, molasses-distilling waste, cement-mill dust, waste from beet-sugar mills and wood ashes. Of these sources, the first are probably the most promising and represent a capital investment of over $20,000,000. At the end of 1920, the sum of $28,696,143 had been invested in the numerous plants within the United States. Some of these plants represent a cost of from $5,000,000 to $6,000,000, others a few thousands.

The American Trona Corporation, with two large plants at Searles Lake, California, is one of the principal producers of American potash. The Searles Lake deposit has been officially estimated by the U. S. Geological Survey as being sufficient to supply the potash requirements of the United States for at least 100 years to come.

Kali Syndikat Gave Warning

The brief emphasizes the deliberate and confident efforts of the Kali Syndikat to prevent the development of an American industry as follows:

"Paul Freudrichsen, whose official title is propaganda manager for the German Kali Syndikat for the Western

ANOTHER PLANT AT SEARLES LAKE

States and Hawaii, came into the offices of the Trona Corporation at different times during the 3 or 4 months immediately preceding the United States entering the World War, and stated . . . that the stockholders of the American Trona Corporation were foolish and unwise to invest their money in a potash reduction enterprise in the United States, for the reason that the German Kali Syndikat and the Imperial German Government would, after the conclusion of the war, absolutely destroy the American potash industry by marketing the German potash in the United States at such low figures as absolutely to preclude and bar any and all competition; that the German Kali Syndikat and the Imperial German Government absolutely controlled the potash production and market of the world, and pictured in great detail the immensity and strength of the German Kali Syndikat, governmentally controlled, and stated that it was useless and futile for any potash reduction enterprise in the United States to undertake to compete with the German potash, for said syndicate and the Imperial German Government intended to destroy all competition."

Threat Carried Out

"The American middlemen and fertilizer manufacturers who purchase the greater part of the potash used in this country found themselves in 1921 in an intolerable situation. The Germans manipulated the market from day to day and week to week, so that there was no stability in the business, and only one thing was certain—the German potash monopoly was underselling the American producers no matter what price was offered.

"In that situation, with some companies facing failure, owing to heavy inventories, and others fearful of making substantial purchases lest they become overstocked, the German agents approached the middlemen and fertilizer mixers with a proposition that seemed to afford some relief. In brief, they offered to sell the harassed middlemen and fertilizer companies any amount of potash at a fixed price which was very low. Then they went further, and stated they would be prepared to undersell any American producer who attempted to meet this already low figure, provided the Americans would agree to purchase all of their requirements from the Kali Syndikat during the term of the contract.

The contract was closed on Sept. 28, 1921, on the basis of the remainder of the season's supply of potash, with thirty-four American concerns dealing in potash as middlemen and fertilizer manufacturers. It provided that these concerns should purchase at the minimum 75 per cent of their requirements. It was held that it did not give the German syndicate a monopoly, since it allowed 25 per cent of the potash requirements of the trade to be supplied from other sources.

"Soon after the signing of the contract with the German Kali Syndikat, a contract similar in terms in almost every word was executed between the Société Commerciale des Potasses d'Alsace, the French potash syndicate, and the same thirty-four American potash middlemen and fertilizer companies, for 25 per cent of their seasonal requirements.

"Under these contracts, the American potash producers now find themselves completely cut off from their market, because 75 per cent of the potash used in the United States is dumped from Germany and the remaining 25 per cent is dumped from Alsace."

Pending Tariff Schedule

The American potash producers believe that the adoption of the compromise schedule which is now before the Senate will adequately protect the industry. The bill provides for a sliding scale duty on potash imports for 5 years, fixed at 50 cents per unit for 2 years, 40 cents the third year, 30 cents the fourth and 20 cents the fifth year, after which time potash will go on the free list. Domestic producers believe that this protection would assure them a reasonable price for their product and thus enable them to plan and build up quantity production. This not only would enable them to cut production costs by the development of efficient processes, but would also permit of more advantageous shipping arrangements.

The Senate Finance Committee promises to report the tariff bill by April 1. The committee has had the bill since July 21, when it was passed by the House. The unprecedented delay in handling the bill has been occasioned by an avalanche of protests against many of the rates provided in the House bill. The rates themselves would not have called out such a volume of objections, had it not been that they were coupled with American valuation, which would have the effect, many think, of increasing these rates materially. The Senate committee is keeping its own counsel. It does not confirm or deny the many rumors that are afloat as to the action it is said to have taken. It is the policy of the committee not to pass with absolute finality on any provision of the bill until it is placed on the Senate calendar.

Production Costs

The freight rate on potash from the Searles Lake region to the Atlantic seaboard is in the neighborhood of 30 cents per unit. The producers of that district believe, however, that quantity production will enable them to establish a water route through the Canal by which they will be able to lay down potash on the Atlantic seaboard at prices which can meet foreign competition.

It is also put forth that a further development of solar evaporation at the lake deposits will further reduce the cost of potash to the consumer. The present production cost has been estimated at $1.10 per unit. The German price, under the recent contract, is 64 cents. Given the protection afforded by the proposed sliding scale of duty, American producers believe that this price difference can be overcome in the 5-year period so that potash will then be put on the free list without fear of foreign competition.

Norwegian Government Considering Establishment of State-Owned Arc Process Nitrate Plants

M. Hagenmann, formerly engineer at the Norwegian Hydro-Electrical Nitrogen Co.'s works, has placed before the Ministry of Agriculture a proposal for the construction and operation of arc process nitrate plants by the government. It is calculated that niter can be sold for between 23 and 24 kroner per 100 kilos—that is, at about two-thirds of the price of Norwegian niter in December.

Claims That Tariff on Cyanide Would Menace Permanence of Gold Standard

A special plea for duty-free cyanide has been made before the Republican members of the Senate Finance Committee by Senator Oddie of Nevada. He told the committee that it is the duty of Congress to insure free cyanide to the gold producers of this country because of the bearing which the production of new gold has on the whole financial structure. He told the committee that a duty would be in the interests of a German trust and that it would discriminate in favor of German manufacturers as against American manufacturers who had located their plants just across the Canadian frontier, so as to obtain the advantages of waterpower. He also told the committee that a duty on cyanide would preclude absolutely the treatment of millions of tons of tailings. He cited the case of the Goldfield Consolidated Co. as a typical one. If cyanide is on the free list, that company will undertake the recovery of the gold content in 1,500,000 tons of tailings. The margin of profit is so narrow, however, that a duty on cyanide would put a stop to the undertaking and prevent the accretion of this new wealth.

Senator Oddie does not hesitate to criticise the attitude of the Secretary of the Treasury, which, in the opinion of the Senator, he has unconsciously taken against the gold industry. In Senator Oddie's opinion, there is only one way to insure the permanency of the gold standard, and that is to speed up the production of gold decidedly. There is a great shortage of gold in all parts of the world except the United States. Unless we turn loose our gold to meet this shortage, he says, some other standard is going to be set up. Secretary Mellon, Senator Oddie believes, is unconsciously playing into the hands of those who oppose the gold standard. His theory of no encouragement for the gold mining industry, says Senator Oddie, is as dangerous to the financial fabric of the world as are the theories of Lenine and Trotsky to its political structure. The proposal to reduce by one-half the amount of gold in gold coin is a part of this same opposition, Senator Oddie believes.

Prohibition of Oil Discharge Into Streams Issue of Moderated Pollution Bills

A new bill designed to protect shore property, fisheries and bathing from oil and acid pollution has been introduced in Congress by Representative Appleby of New Jersey. It confines the prohibition to the discharge of oil and authorizes the Secretary of Commerce to make investigation as to the effect of pollution of other discharges upon fish, reporting in 2 years with remedial legislation. Previous bills on the subject would have affected mining, coal and chemical industries by the inhibition of pollution of navigable waters.

The new bill prevents oil pollution only, including, however, oil of any kind or in any form, such as fuel oil, oil sludge or oil refuse. Except for smoothing the sea or quelling the force of waves in case of emergency and except as otherwise permitted by regulations of the Secretary of War no person or vessel would be allowed to discharge oil or permit it to run or flow into navigable waters of the United States. The Secretary of War would prescribe regulations for the use, handling and disposition of oil and for equipment of structures and vessels as will prevent oil from being discharged into such navigable waters. As punishment for violation, the offender would be subject to a fine of $2,500 or to 30 days imprisonment, or both, and denial of clearance of vessels from United States ports until the penalty was paid, and in addition revocation or suspension of license of the masters of the vessels. The penalties would not begin until 3 months after the law became effective.

The bill authorizes the Secretary of Commerce to determine what substances if any other than oils are emptied into navigable waters in such manner as to endanger or interfere with navigation, commerce or fisheries, reporting in 2 years with legislative recommendations.

Senator Frelinghuysen of New Jersey has introduced a bill identical with that introduced in the House by Representative Appleby.

Brigadier-General Fries Emphasizes Value of Chemical Warfare Service

The drastic reduction in the appropriation for the Chemical Warfare Service recently prescribed by the House Appropriations Committee has aroused a storm of protest from those who feel that necessary defensive research will be crippled by lack of funds. Although it is generally felt that the agreement of the Arms Conference definitely outlawed the production of poison gases, there is considerable doubt as to what extent a national defense program demands research in order to be on guard against the use of gas by unscrupulous enemies.

Brigadier-General Amos A. Fries, chief of the Chemical Warfare Service, has issued a statement, dated March 21, in which he points out the place filled by the Chemical Warfare Service during the war and outlines the value of such service for the future. Extracts from the statement follow:

Whether or not a service shall be separate under the General Staff depends on whether that service is fundamentally different from all other services. We have a Chemical Warfare Service to handle all general chemical problems just as every great organization today has a chemical, research, development and proving organization distinct from its engineering organizations.

The present work of the Chemical Warfare Service can be largely extended to the benefit of the army and navy. Wherever general chemical investigation or development is needed, whether research, small-scale manufacture or the proving out and testing of chemicals, the Chemical Warfare Service, with its highly trained personnel, its close contact with chemical societies, the chemical business industries and chemical research institutions, can do the work quicker and cheaper than any other agency available to the army or navy. Likewise, whenever information on any chemical subject is needed, the Chemical Warfare Service, through its contact with the above-named agencies and all governmental departments interested in chemistry, can collect the information in the form desired quicker and cheaper than any other agency.

Interpretation of Gas Treaty

The treaty concerning submarines and gases does not pretend in any way whatsoever to abolish the Chemical Warfare Service. It is simply an agreement not to use gas against each other in war. Our allies in the World War—England and France—through their representatives, particularly emphasized this point, thereby making it clear that they expected to go right ahead with full preparations in chemical warfare even to the extent, if necessary, of accumulating supplies of war gases and the shells and other containers in which to use them to meet a possible violation of the treaty by a signatory power or the refusal of some power not to sign the treaty.

Protection against gases in war can be achieved only by the mask and protective clothing. We must have these in perfect shape and ample quantities, based on chemical knowledge that is kept up to the minute. Without them a gas attack means annihilation to an army.

Question of Economy

No economy can be achieved by its combination with any other service. As before stated, chemistry is such a fundamental and far-reaching science that men must give their entire time to it if they are to achieve efficiency. That being true, there could be no efficiency in putting it under another service, because it would not decrease personnel. Indeed, under another service its cost would be greatly increased through loss of the esprit de corps of the workers and the loss of the support of the profession and industries represented in civil life by chemistry.

Functions Other Than Poison Gas Research

The Chemical Warfare Service has from the beginning handled not only research, proving, development and manufacture and supply of war gases, but the research, development, proving, manufacture, filling into containers and supply of all smoke and incendiary materials. Incendiary materials, except as incidental to smoke, are of comparatively little importance. Smoke, however, on account of its extraordinary screening properties, is of vital importance to the army and the navy.

There is one phase of the work of the Chemical Warfare Service not yet touched upon. It is, however, of vital importance. It lies in the twilight zone between the work of the medical department and pure chemistry. It is pathology, or the study of the effects of gases and other chemicals on flesh, whether fowl, beast or man. It is absolutely essential in determining whether a gas is powerful enough for use in war. This study is just as necessary for defense as it is for offense. It is a guide to what the enemy may use. It is used first to determine the toxicity of various chemical compounds, of which there are several hundred known. It becomes the final test in the field as to whether the result achieved in the laboratory can be reproduced practically in war.

Chicago Engineers Told of Research Work on Insulating Materials

Speaking before a joint meeting of the Chicago Section of the American Society of Mechanical Engineers and the Western Society of Engineers March 20, Dr. Edward R. Weidlein outlined the development of the Mellon Institute of Industrial Research. It had been expected that Dr. Weidlein might give some results of the high-temperature insulation work which the Institute is now conducting, but as this subject is to be reserved for the spring meeting of the Mechanical Engineers, consideration of this phase was limited to the general characteristics of 85 per cent magnesia insulation. The accepted figure of loss from bare pipe of 3 B.t.u. per hr. per sq.ft. per degree difference in temperature has been found to be higher as the temperature of the steam is increased and to vary with the diameter of the pipe. With insulated pipe the loss increases slightly with the temperature, but in no such ratio as for bare pipe. Enthusiastic discussion followed on insulation for underground piping, the effect of air velocity over the piping and a variety of subjects.

Memorial Fund to Stimulate Study of Chemistry Planned in Honor of Charles Baskerville

The faculty and students of the College of the City of New York have launched a drive for the collection of funds for a memorial to the late Charles Baskerville. According to present plans the memorial will take one, two or all three of the following forms:

1. The placing of a bronze tablet on the Chemistry Building, which is to be renamed Baskerville Hall.
2. The founding of a fund to provide for a medal to be called the "Charles Baskerville Prize" and to be awarded each year to the student doing the best work in chemistry.
3. The establishment of a scholarship to permit students who qualify to pursue advanced chemistry courses in other technical schools either here or abroad.

Friends of Dr. Baskerville who wish to contribute to this fund should send contributions to Prof. W. L. Prager, Department of Chemistry, College of the City of New York.

Prepares National Pure Paint Bill

Ingredients of all paints and varnishes handled in interstate commerce must be listed on the container, if legislation being drafted by Senator Ladd of North Dakota is written on the statute books. Senator Ladd was influential in obtaining the pure paint law in North Dakota. That law has been in effect for 12 years and according to Senator Ladd has proved to be a boon to the public and to paint manufacturers. He will make national legislation to the same effect one of his principal objectives. He expects to obtain the co-operation of a number of manufacturers of paints and varnishes.

Expect Tariff Bill to Be Reported This Week

While the dye schedule of the tariff bill is still subject to change, the Finance Committee of the Senate is understood to be in practical agreement on a duty of 7 cents a pound and 50 per cent ad valorem on intermediates and 7 cents a pound and 60 per cent ad valorem on finished coal-tar products. It is expected that the tariff bill will be reported to the Senate March 31.

Congressional Committees Considering Muscle Shoals Offers Visit Plants

Three days in actual inspection of the Muscle Shoals, Ala., nitrate plants will be spent by members of the Senate Committee on Agriculture and the House Committee on Military Affairs in their consideration of the various proposals to lease the property. The inspection by the legislators will be divided into a 1-day visit to the Gorgas steam plant on the Warrior River and 2 days at Nitrate Plants No. 1 and No. 2.

The official party left Washington at 10 p.m. March 25 and was scheduled to arrive at Parrish, Ala., in the morning of March 27. Members of the Senate committee who are making the trip are Senators Norris of Nebraska, Heflin of Alabama, Harrison of Mississippi, Kendrick of Wyoming, Ransdell of Louisiana, Smith of South Carolina, Caraway of Arkansas, Ladd of North Dakota and Norbeck of South Dakota. Other Senators accompanying the committee were McKellar of Tennessee, Harreld of Oklahoma, McKinley of Illinois, Stanfield of Oregon and Nicholson of Colorado. Ten members of the House Committee on Military Affairs made the trip. A number of the members of the committee were unable to go on account of other activities and the size of the delegation also was limited by the $2,000 appropriation made to cover its expenses. The House members who made the trip are Hull of Iowa, James of Michigan, Kearns of Ohio, Miller of Washington, Hill of Maryland, Wurzbach of Texas, Quin of Mississippi, Fisher of Tennessee, Wright of Georgia and Stoll of South Carolina. The first day was to be spent in visiting the Gorgas plant. March 28 and 29 were scheduled for the inspection of the nitrate plants, the party returning to Washington March 31.

Senator Lodge of Massachusetts, Senate leader, expressed a desire that the committee defer its investigation of the plants until after the vote on the naval limitation treaty, but the Senate Agricultural Committee decided that as the trip would be short the business of the Senate would not be delayed unduly by the absence of the Senators.

Chemical Industries Protest Revival of Patent Convention of 1909 With Germany

Action by the Senate, authorizing the President to revive the patent convention entered into with Germany in 1909, has raised a storm of protest. As a result it seems probable that the President will withhold the notice reviving that treaty, pending an investigation.

The 1909 patent convention with Germany provides that, in case the United States should amend its patent laws by the insertion of a working clause, this legislation would not apply to patents of German origin. The agreement is reciprocal.

There are certain American industries which are anxious to have this reciprocal safeguard, but the arrangement is regarded as being a very detrimental one to the domestic chemical industry. The situation is made the more serious by the determination of Senator Ladd of North Dakota to push his bill requiring that patents be worked within certain periods or be forfeited. Senator Ladd is convinced that there is a growing sentiment in this country for the addition of a working clause to the patent code.

The Synthetic Organic Chemical Manufacturers' Association has voiced objection to the revival of the convention before adequate provision is made by enactment of legislation that will prevent the same situation developing in the future that faced American organic chemistry prior to the war. The attitude of this association was expressed in a letter written by Charles H. Herty, its president, to Under Secretary of State Fletcher.

The American Institute of Chemical Engineers has also set forth its objections in a memorandum forwarded to Mr. Fletcher by the president of that organization, Henry Howard, of Cleveland, Ohio. In his letter of transmittal Mr. Howard declares that it would be "nothing short of a calamity if the President should cause the patent convention treaty with Germany to be reinstated." Extracts from the memorandum follow:

"It is a known fact that this treaty was conceived and engineered by certain chemical interests of Germany and these same interests in the United States because of their fear that the United States would pass a law providing for some kind of a 'working clause' in its patent system.

"The German chemical interests realized that if they were obliged to work their patents in the United States it would be the beginning of the end of their absolute monopoly in the United States of the synthetic organic chemical industry.

"The willingness of the German Government to enter into such a treaty was from Germany's point of view almost solely to prevent a possible injury to its monopoly in the United States above referred to, and clearly shows the enormous value that those in control of the German Government placed on this monopoly and the sacrifices they were prepared to make to maintain it.

"We maintain that it is improper to allow the monopoly granted by our own patent law to be used either by an American or by an alien to foster the development of a new industry in a foreign country and at the same time to make use of this patent monopoly to prevent such new industry from being developed in the United States."

Technical Societies Interested in Philadelphia Sesquicentennial

A very pronounced feeling exists in engineering circles in Washington that the proposed Engineering Congress to be held in connection with the Philadelphia Sesquicentennial should be promoted in a national and international way, and that this can be done best by the Federated American Engineering Societies. Local promotion of the Congress would be handicapped, it is believed, by the assumption that Philadelphia engineers naturally would be inclined by the incidental benefits to their city to represent such a gathering as certain to be a momentous occasion. If the arrangements were handled by the national machinery which the organizations in many branches of engineering have set up, it is believed a different impression will be created.

At a recent meeting of the Philadelphia Section of the American Chemical Society, a national meeting of the society in Philadelphia during the Sesquicentennial Exposition in 1926 was urged.

Mexican Chamber of Commerce of U. S. Formed

Announcement is made of the organization and incorporation of the Mexican Chamber of Commerce of the United States. The object of the organization is the promotion of business and economic relations between Mexico and the United States and the dissemination of general information of reciprocal interest. The directorate is composed of an equal number of citizens of the two countries. It is said that considerable preparatory work done prior to its organization enables the Chamber to offer immediate service. Offices are established in the Woolworth Building, New York City, and at 45 Bolivar St., Mexico City.

To Explore New Territory for Oil

Arrangements have been made between the Canadian Government and Chester P. Thompson, managing director for the Thompson Oil Syndicate and for the Sanctuary Oil Co., whereby these companies will explore and in the event of discovery develop the Pakow-Ski Bird Reserve for oil and natural gas. The reserve consists of 1,920 acres and is situated in southern Alberta, just north of the international boundary.

Examination Announced for Computer Cyrogenic Lab

The United States Civil Service Commission announces an open competitive examination for computer, cyrogenic laboratory, on April 26, 1922. A vacancy in the Bureau of Mines and positions requiring similar qualifications, at $1,800 to $2,500 a year, will be filled from this examination. Applicants should apply at once for Form 1312 to the Civil Service Commission, Washington, D. C.

Enlarged German Chemical Exposition Scheduled for Hamburg in June

In connection with the general meeting of the Verein Deutscher Chemiker at Hamburg, June 7 to 11, the Fachgruppe für chemischer Apparatewesen of this society will hold its third annual exhibition of chemical apparatus, products and processes. The full title "Ausstellung der Fachgruppe für chemisches Apparatewesen" is shortened to "Achema." At Achema I in Hannover, 1920, 4,000 visited the 75 exhibits, which occupied 3,770 sq.ft. of floor space. In Stuttgart, in 1921, 120 exhibitions used 10,750 sq.ft. and there were 8,100 visitors. The space available for Achema III will be approximately 25,000 sq.ft. It is planned to continue the exhibition for a week after the close of the general meeting of the Verein Deutscher Chemiker. This society is composed largely of industrial chemists, the present membership being over 6,500.

Paper Week in New York

The week of April 10 is designated as paper week in New York, meetings of all the important associations of pulp and paper manufacturers being scheduled for that week. The annual meetings of the American Pulp and Paper Association and the Technical Association of the Pulp and Paper Industries will be held at this time, headquarters to be established in the Hotel Waldorf-Astoria. Monday will be devoted to committee meetings, Tuesday and Wednesday to general meetings and sectional meetings. The majority of the sectional meetings will deal with the technical problems of the industry. The annual banquet will be held Tuesday and the election of officers on Wednesday.

Industrial Films to Be Censored by Experts

A board of censorship for technical and industrial moving pictures has been set up by the Bureau of Mines, in conjunction with the Department of Commerce. T. T. Read is the representative of the Bureau of Mines on the board and Oliver P. Hopkins represents the Department of Commerce. These two members are to select a third member, who is to be a specialist in the activity with which the picture deals. In each instance, at least two additional persons familiar with the subject of the picture are to sit with the committee in an advisory capacity. While only the pictures prepared in the Interior and Commerce Departments will be subject to the board's jurisdiction, it is believed that other departments and outside agencies preparing industrial moving pictures will seek to have films reviewed.

Personal

EDWARD L. DOHENY, president of the Mexican Petroleum Company, New York, has started on an inspection trip of the company's properties in Mexico, accompanied by Edward L. Doheny, Jr., and a number of other officials of the company.

CHARLES B. DURGIN has been granted a 6 months' leave of absence from the U. S. Department of Agriculture and is now doing research work for the Federal Phosphorus Co. of Anniston, Ala.

DR. ARTHUR D. HIRSCHFELDER, professor of pharmacology of the University of Minnesota, addressed a recent meeting of the Rochester Section of the American Chemical Society, on "The Chemistry of Drugs."

S. M. KINTER has been appointed manager of the research department of the Westinghouse Electric & Manufacturing Co., succeeding C. E. SKINNER. He will be located in the research laboratory building near East Pittsburgh, Pa.

M. M. MARCUS, general superintendent of the Rhode Island Malleable Iron Works, Hillsgrove, R. I., spoke before the Providence Engineering Society, March 14, on certified malleable iron castings, describing the modern scientific practice in their manufacture.

GEORGE A. MILLER, JR., resigned as chief metallurgist of the Frankford Arsenal, Philadelphia, March 8, after 5 years in charge of the research metallurgical laboratories, to accept a position with the Lakecrest Citrus Products Co., South Lake Weir, Marion County, Fla., as chief chemist and general manager in the manufacture of citrus byproducts, etc.

DR. R. B. MOORE, of the Bureau of Mines, delivered an address entitled "The Rare Gases: Their History, Properties and Uses," before the Chemical Society of Washington, on March 16. The address was illustrated with lantern slides.

G. M. NORMAN, chemical director of the Hercules Powder Co., Wilmington, Del., becomes technical director, April 1, in charge of both the chemical and engineering departments. W. C. HUNT will become assistant technical director.

L. C. SADD, of Pittsburgh, Pa., has been elected president of the Pittsburgh Paint, Oil and Varnish Club for the ensuing year. L. C. STUCKRATH has been elected vice-president and J. D. WATSON treasurer. GEORGE F. SMITH has been re-elected secretary for the twenty-eighth term.

C. E. SKINNER, manager of the research department of the Westinghouse Electric & Manufacturing Co., has been appointed assistant director of engineering in that company. His new duties will cover research, standards and other work along these lines. He will be located in the main engineering offices at East Pittsburgh, Pa.

J. B. WIESEL, formerly in the nitro cotton division of the Wilmington, Del., office of the Hercules Powder Co., has been transferred to the Union Plant at South River, N. J., as superintendent.

Obituary

PHILIP ARGALL, mining and metallurgical engineer, of Denver, Col., died in that city on March 19, at the age of 68, after a short illness. Mr. Argall gained prominence in his profession due to his successful treatment of low-grade Cripple Creek gold ores by the process of cyanidation. He had been identified with the mining industry of the Rocky Mountains for many years, having come to the United States from Ireland in 1887. In the course of his professional life Mr. Argall proved himself a worthy pioneer in engineering and technology and a vigorous writer in defense of his ideas. He was a member of the Mining and Metallurgical Society of America, the Colorado Scientific Society, the Institute of Mining and Metallurgy (London) and the Royal Irish Academy.

HENRY A. LAUGHLIN, one of the pioneers of the iron and steel industries in the United States, died on March 11 at his home in Chestnut Hill, a suburb of Philadelphia. He was 84 years old, and retired from active business 22 years ago. Mr. Laughlin was chairman of Laughlin & Co., Ltd., until that concern was absorbed by the Jones & Laughlin Steel Co. He was a director in the last named company when he retired in 1900.

BENJAMIN MAGNUS, consulting engineer and specialist in electrolytic refining, died at Poughkeepsie, N. Y., on March 12, 1922. Mr. Magnus was born in New York on June 23, 1878, and was educated at Columbia University, where he received the degree of electrical engineer in 1900. He was superintendent for the Anaconda refineries 1900-1903, after which he was for several years in the employ of the Calumet & Hecla Co. of Michigan and the Mountain Copper Co. of California. In 1907 he went to Australia, where he remained until 1916, being successively general manager for the Electrolytic Refining & Smelting Co. and the Mt. Morgan Gold Mines. Returning to New York he engaged in consulting practice until his death. During the war he served as a Captain in the 140th Engineers. He was a member of the American Institute of Mining and Metallurgical Engineers, Mining and Metallurgical Society and the American Electrochemical Society.

Market Conditions

IN CHEMICAL, METALLURGICAL AND ALLIED INDUSTRIES

A Survey of the Economic and Commercial Factors That Influence Trade in Chemicals and Related Commodities—Prevailing Prices and Market Letters From Principal Industrial Centers

Signs of Progress

At least two of the favorable factors commented on in our recent review of February's contribution to fundamental business progress have now been confirmed by the official figures of the United States Bureau of Labor Statistics. We refer to the noticeable increase in the volume of employment that occurred during February and to the distinctly upward trend in wholesale prices. In the case of the latter the pronounced rise in the value of farm products and foodstuffs has done much to correct the maladjustment in the price levels of the principal groups of commodities. The spread between manufactured products and those of agriculture has been a serious deterrent to progress. Now the gap between the products the farmer wishes to sell, such as grains and live stock, and those he wishes to buy, such as farm implements and other manufactures, is apparently being closed in from both directions.

The rapid advances in cotton, wheat, corn, oats, rye, flaxseed, cattle, hogs and sheep caused the bureau's weighted average of 116 in January to rise to 126 in February, an increase of over 8½ per cent. Metal and metal products, on the other hand, decreased approximately 1¾ per cent in February and housefurnishings one-half of 1 per cent. Furthermore, clothing, fuel and lighting, building materials, and chemicals and drugs show no change in price levels.

The general index for all commodities, which is based on a series of 327 articles, increased from 148 to 151. The index numbers for the individual groups are as follows:

INDEX NUMBERS OF WHOLESALE PRICES, BY GROUPS OF COMMODITIES (1913 = 100)

	1921, February	1922, January	1922, February
Farm products	129	116	126
Food, etc.	150	134	138
Cloths and clothing	198	183	183
Fuel and lighting	218	183	183
Metals and metal products	146	117	115
Building materials	221	202	202
Chemicals and drugs	178	159	159
Housefurnishing goods	277	214	213
Miscellaneous	180	146	150
All commodities	167	148	150

Comparing February's prices with those of a year ago, it will be seen that the general level has declined approximately 9½ per cent during this period. Metals have shown a decrease in average price, as measured by these index numbers, of 21 per cent, chemicals and drugs 10½ per cent and building materials 8½ per cent.

Changes in Employment and Wage Rates

Tabulations from representative establishments in thirteen manufacturing industries and in the bituminous coal mining show that there was a striking increase in the volume of employment during February. The figures show that in ten of these industries there were increases in the number of persons on the payroll in February as compared with January and in only four were there decreases. The largest increase, 9.3 per cent, was in the iron and steel industry, where the survey included 108 establishments. Fifty-seven paper mills reported an increase of 1.4 per cent in the number on their payrolls in February as compared with January. In thirty-seven leather plants the increase in employment was 1.8 per cent.

Wage changes in some of the chemically controlled industries are reported in the following paragraphs.

Leather.—A decrease of 12 per cent, affecting 87 per cent of the force, was reported by one tannery. About 35 per cent of the men in one establishment were reduced 10 per cent in wages, while 75 per cent of the men in another establishment had a wage rate decrease of approximately 8 per cent. An increase of 2.7 per cent in per capita earnings appeared when January and February figures were compared.

Iron and Steel.—All employees in one mill were reduced 25 per cent in wages, while in two other mills the reduction to all employees amounted to 15 per cent. A decrease in wage rates of 13 per cent was made to 65 per cent of the men in one establishment. Four establishments reported a wage reduction of 10 per cent, affecting approximately 50 per cent of the force; while in four other establishments one-half of the employees were reduced 4½ per cent in wages. A wage cut of 8 per cent, affecting 50 per cent of the force, was reported by one concern. Another concern reduced the wages of 18 per cent of the employees about 3 per cent. Increased force and amount of time worked were reported for this industry. An increase of 5.9 per cent in per capita earnings was shown when January and February payrolls were compared.

Paper Making.—In three mills a decrease of 10 per cent in wages was made, affecting the entire force in one mill, 95 per cent of the force in the second and 36 per cent of the force in the third. One-tenth of the men in one establishment were cut 6¼ per cent in wages. Business conditions remained much the same for this month and the per capita earnings show no change when compared with the past month.

CHEMICAL & METALLURGICAL ENGINEERING'S WEIGHTED INDEX OF CHEMICAL PRICES

Base = 100 for the year July 1, 1913, to June 30, 1914

This week	**157.65**
Last week	157.49
March, 1921	157
March, 1920	252
April, 1918 (high)	286
April, 1921 (low)	140

The index number again remains practically unchanged and continues at the higher level reached early in the current month. During the past week eight of twenty-five commodities included in this compilation changed in price. Prices for five of them—citric acid, ammonium sulphate, barium chloride, caustic potash and potassium carbonate—increased and three—formaldehyde, bleaching powder and linseed oil—were selling at lower prices.

Raising Output and Reducing Costs

A number of manufacturers in their efforts to reduce production costs have turned their attention to their personnel departments, where by improving industrial relations they hope to eliminate lost motion and to obtain greater efficiency from the individual workers. The policies pursued by the American Smelting and Refining Co. are illustrative of this principle. According to a recent report, a "job analysis" covering every operation was made in one of the company's larger plants so that each employee could fully understand his function in the operation, his efficiency, the purpose, limitations and the possibilities of his position, as well as the character and necessity of the work leading up to his activity. In other words, he was acquainted with the scope and meaning of every step in the production of the company's product.

Classes were formed in executive and administrative work, in foremen's general training, and in vocational instruction. The company reports that "out of this industrial training has grown a better and closer supervision by plant executives, so that the working force on each operation has been reduced to a minimum never before

reached and a much greater production per man has been obtained."

A few figures taken from operating records at some of the company's plants during 1921 will illustrate this increase in efficiency:

Plants	Operation	Tons Per Man—Per 8-Hour Day Average 1914	Tons Per Man—Per 8-Hour Day Average Oct., 1921
Durango	Crushing	31.8	52.2
Murray	Unloading	9.2	25.3
Arkansas Valley	Roasting	6.4	13.6
El Paso	Bricking	2.0	4.4

The effect of these managerial policies on labor costs is summarized in the statement:

"In 1914, repair, supply and construction labor was paid an average of $2.42 for an 8-hour day, while in November, 1920, the rate was $5.39, an increase of 123 per cent. In December, 1921, through various readjustments, the rates for repair, supply and construction labor had been reduced to $4 for an 8-hour day. This was a decrease of 25.9 per cent below the highest rate, $5.39, paid in November, 1920."

Another saving has resulted from the installation of efficient mechanical equipment in all places where it was certain that it would reduce labor-hours per ton. This has been an important factor in lowering costs due to savings both in time and material.

Twenty-Two New Chemical Companies Organized in February

According to the compilations of the *Journal of Commerce*, twenty-two companies were organized in February for the manufacture and distribution of chemicals, drugs and dyes. The indicated investments totaled $5,200,000. In January, 1922, there were thirty-two new companies, with an aggregate investment of $37,650,000.

In the month of February a year ago the total capitalization of new organizations in the drug and chemical fields reached $12,585,000. Sixty-five new companies, each with a capitalization of $50,000 or more, were also organized in February, 1922, to engage in the petroleum industry. This compares with ninety-two such companies in January. The gross capitalization of the first noted reached $100,173,000, as against $100,250,000 in the preceding month.

The following table shows the new capital in drug and chemical concerns since August, 1914:

Five months of 1914	$16,838,000	1918	$73,403,000
1915	65,565,000	1919	112,173,000
1916	99,244,000	1920	487,148,000
1917	146,160,000	1921	108,410,900

Market and Financial Notes

German Potash Prices Are Advanced.—A dispatch from Berlin on March 21 states that an increase of 21 per cent in the market prices of potash salts had been granted the Kali Syndikat by the Imperial Potash Council. The producers, who submitted their petition to the government on March 15, declared that the higher prices were necessary because of further increases in the wages paid in the mines and to a recent advance in the freight rates on potash salts.

American Linseed Co.—The 1921 report of this company showed an operating loss of $1,043,132, as compared with a profit of $6,238,597 for the 15 months ended Dec. 31, 1920.

U. S. Cast Iron Pipe & Foundry Co.—This company had a net profit of $100,841 for the year ended Dec. 31, 1921, according to its recent report. Approximately $432,000 was charged off for depreciation.

Mathieson Alkali Shows Deficit.—The Mathieson Alkali Works, Inc., reported a net loss of $149,635 in 1921, as compared with a net profit of $524,874 in 1920. The profit and loss surplus on Dec. 31, 1921, was $1,479,932 and on the corresponding date in 1920, $1,684,347.

Freeport Sulphur Co. and the Texas Co. Agreement.—In the annual report of the Freeport Texas Co. for the year 1921, President E. P. Swenson states that the subsidiary, the Freeport Sulphur Co., has entered into a contract with the Texas Co. for taking over the latter's sulphur deposits in Hoskins Mound, Brazoria County, Texas. It is understood that the arrangement is on a contingent royalty basis.

The New York Market

NEW YORK, March 27, 1922.

The chemical market during the past week showed pronounced signs of expansion and business in the aggregate was much better, although there still remain some traces of small-scale operations. There have been instances of both shading and advancing prices on various commodities according to the demand. In the first-hand market March sales have probably not been quite up to the standard established during February. This condition is accounted for by the fact that for a number of reasons the large consumers greatly increased their February allotments. The resale market, however, has not had any setback so far this month and in many cases jobbers have completely withdrawn from trading circles in order to await higher prices.

GENERAL CHEMICALS

Caustic Potash.—Supplies of spot material have noticeably diminished on the 88-92 per cent imported grade, with buyers showing a little more interest in covering requirements. Small sales were reported at 6c. per pound early in the week, but later quotations were around 6¼c. Stronger conditions in this commodity abroad have also had a better influence on spot values.

Carbonate of Potash.—A reduction in offerings and an improved demand are directly responsible for the sharp advance in this commodity. The 80-85 per cent calcined was advanced to 4¼c. per pound.

Bleaching Powder. — Prices on domestic material are a trifle lower. Leading sellers offer large drums at $1.70 per 100 lb., f.o.b. works, and report sales at this figure. The range is up to 2c. per pound. Imported goods are quoted at $1.85 per 100 lb. The demand has slackened off considerably.

Barium Chloride.—Prices have advanced sharply and the market is in a very firm condition. Goods afloat sold at $75 per ton. Spot material was held at $80@$85 per ton according to seller and quality. The demand was very brisk.

Caustic Soda.—Dealers report March material exceedingly firm for export and quote prices around $3.70 per 100 lb. Some sellers have booked goods far into June and state that their output for earlier months is entirely sold. Producers have not altered quotations and ask 2¼c. per pound, basis 60 per cent, f.o.b. works, in carload lots.

Citric Acid.—The market showed a much firmer tendency and while the demand as yet is not especially active, spot prices have been pushed ahead by prominent sellers of imported goods. The closing price on spot was 46c. per pound. Shipments were quoted at 45c., c.i.f.

Formaldehyde.—Some manufacturers have reduced prices to 8½c. per pound, f.o.b. works, with the general quotation at 8½@9½c. per pound, depending on quantity. Competition is responsible for the present low price, which is recorded as the lowest since July, 1915.

Prussiate of Soda.—The consuming demand has fallen off considerably and the change in the market has resulted in a decided reduction in quotations. Prices as low as 17¼c. per pound were heard with the range from 17½@17¾c.

Oxalic Acid.—Continuous competition among first hands has resulted in lower prices on spot and at the works. The best price heard was 11½c. per pound. The general quotation was from 11½@12½c. per pound, depending on quantity and brand.

Sal Ammoniac.—Shipments of this material from abroad are much firmer and the market is quoted at 6¾c. per pound, c.i.f. New York. Spot prices are higher with sellers asking 7¼c. per pound for the white and gray goods.

Sulphate of Ammonia.—This material continues to be in extremely limited supply and the few who can offer goods for immediate shipment are asking 3½c. per pound.

Sulphide of Soda.—There has been a decided improvement in this material, with several sellers refusing to shade 4½c. per pound, for the fused 60-62 per cent on spot. Goods afloat were quoted at 4½@4¾c. per pound. Domestic material was held firm at 5¼c. per pound.

COAL-TAR PRODUCTS

Benzene.—Producers of this material have found a ready market since the beginning of the year and prices have been

firmly maintained on both grades. Spot goods are exceedingly scarce and regular contract shipments are still uncertain for any definite deliveries. The 90 per cent is quoted at 27@32c. per gallon and the pure water white is being held at 29@35c. per gallon. Resale material on spot is nominal at 40c. per gallon for the 90 per cent.

Solvent Naphtha.—Sales of crude are reported by producers on the basis of 22c. per gallon, while small lots have brought as high as 27c. Pure water white is moving on contract at 25@28c. per gallon. Crude heavy is held at 10@14c. per gallon.

Anthracene.—Producers report a fair inquiry for the different grades and are booking shipments at 75c. per pound for the 80-85 per cent test and at 15c. per pound for the 40-45 per cent. The low-grade 20-25 per cent material is moving on the basis of 11c. per pound.

The Chicago Market

CHICAGO, ILL., March 23, 1922.

Better conditions were to be noted in the industrial chemical market during the past week. Buyers, while still inclined to shop around considerably before placing an order, are taking on supplies in a somewhat larger volume. Prices with a few exceptions are very firm and spot stocks are only moderate. It is evident that the tendency of the market is toward higher prices, but no radical revision upward is expected in any quarter.

GENERAL CHEMICALS

Caustic soda, while firm, lacks quotable change, and supplies are reported to be only moderate. Solid 76 per cent is priced at $3.75 per 100 lb. and the ground at $4.50. *Caustic potash* continues in a very firm position, with small supplies offered at 6½c. per lb. delivered. *Soda ash* is moving in a routine way at $2.30 per 100 lb. for 58 per cent material in cooperage.

Alum is showing a slightly firmer tendency and is quoted at 5@6c. per lb. for lumps and 6@6½c. for powdered. *Bleach* is in fair demand and can be had in single drum lots at 3c. per lb. *White arsenic* continues firm, with small parcels quoted at 8½@9c. per lb. *Copper sulphate* is said to be moving fairly well, with $5.90 per 100 lb. the best figure noted for small lots. *Copperas* is in some demand and is available in single-barrel lots at $1.75 per 100 lb. *Carbon bisulphide* is unchanged at 6¾@7c. per lb. in single-drum lots. *Carbon tetrachloride* is in somewhat better demand at 10½@11c. per lb. *Formaldehyde* is said to be moving well, but due to the unstable condition of the methanol market the price is easy at 9½@10c. per lb. *Glycerine* is showing no improvement and c.p. material in drums is quoted by refiners at 16c. per lb.

The *bichromates* are in routine demand and lack quotable change at 11¾c. per lb. for the potash and 9@9½c. for the sodium. *Potassium permanganate* is steady at 17c. per lb. for the U.S.P. crystals and is reported to be moving fairly well in small parcels. There are as yet no supplies of *red prussiate of potash* on the market and as far as could be determined nothing for near future delivery. *Yellow prussiate of potash* is very firm, with only moderate supplies available at 28@30c. per lb. *Sodium bicarbonate* continues to move in the regular consuming channels at $2.30@$2.40 per 100 lb. *Sodium fluoride* has shown a better demand of late and is moving fairly well at 10½@11c. per lb. *Hyposulphite of soda* is being bought by the photographic trade in a better volume and pea crystals are quoted by manufacturers at $3.25 per 100 lb. for barrels.

LINSEED OIL

Linseed oil was reported by a prominent factor to be moving in a very satisfactory volume. For the past week the tendency on this material has been down, but this has had little effect on the movement. Boiled oil was quoted today at 84c. per gal. in 5-drum lots and the raw oil in similar quantities at 82c.

NAVAL STORES

Turpentine is enjoying a very good demand and the market is firm. Today's price for 5-drum lots was 87c. per gal. *Rosin* is moving freely and with supplies heavy the competition is very keen. The WG grade was quoted today in carlots at $6.85 per 280 lb.

The Iron and Steel Market

PITTSBURGH, March 24, 1922.

The disparity in views in different quarters as to the nearby future of the steel market is much more pronounced. The divergence of opinion is so wide that a clarification within a few weeks is practically certain. In some quarters it is predicted positively that demand for steel will continue to increase in marked fashion, say to the extent that by June 1 production will be at 25 per cent greater rate than at present. In other quarters it is asserted that the call upon the mills for steel lately has been greatly in excess of the consumption, it being insisted that if the country were consuming steel at the producing rate the general appearance of industry would be quite different from that actually presented.

Those who maintain that demand will continue to increase argue that the material recently bought has been urgently needed or the buyers would not have insisted upon quick shipment as they did, that the season of the year promises an increase in consumption and that the railroads are buying more and more freely.

Those who maintain that the demand is already above a natural relation with the state of business generally suggest that buyers have simply been partly restoring their extremely depleted stocks, and probably have anticipated some of their requirements, in fear that the coal strike April 1 would interfere with production and shipments of steel.

A few weeks will stop this debate, for one party or the other will be forced to see its error. The respective sets of premises on which they argue cannot stand side by side for any length of time.

Production of steel ingots is running along at between 29,000,000 and 30,000,000 tons a year, showing but a slight increase in the past 3 or 4 weeks. Some companies are preparing to increase operations, however.

PRICES

Whatever may be theory, as to commodities being marked for intermittent price declines for several years, or as to steel prices being below cost of production, the plain market fact is that in no branch of the finished steel market has there been any decline for 2 or 3 weeks past, while in some respects there has been a stiffening. The price decline may be resumed any number of times in the future, but the present fact is that the long decline, which really dates back to the latter part of 1920, stopped a fortnight or more ago. Bars, shapes and plates are firm at a minimum of 1.40c., and some business has been booked in the past few days at 1.45c. and 1.50c. while recently there was not a little business done at well under 1.40c. Several mills have formally announced that a 1.50c. minimum is their objective. Nails have been quite steady at $2.40 in recent weeks, while formerly this price was shaded somewhat. In sheets it looks as if there might be an advance from the prices ruling for over 3 months, but only after customers were given an opportunity to place orders at current prices. One independent mill has announced an advance of $3 a ton, from 3c. for black, 4c. for galvanized and 4.35c. for automobile sheets, to become effective April 1. In pipe the shading does not seem to be any greater than in the past.

By fairly heavy absorption of spot and prompt furnace coke last week the price of $3.25 has disappeared in the Connellsville trade, leaving $3.50 as the market, but demand has been light this week and additional ovens are going in. Foundry coke remains at $4.25@$4.75. Demand for Connellsville coal has become light and prices are lower. A decline in the market for Pittsburgh (union-mined) coal is also seen. There is no diminution in the prospect as to the suspension at the union mines April 1, and the market development therefore indicates that consumers generally were forehanded in laying in stocks, so as to avoid a possible rush in the last 2 or 3 weeks of March. Accordingly there is the reverse of a rush.

Pig iron remains quotable at $19.50 for bessemer, $18 for basic and $19 for foundry, f.o.b. valley furnaces, with $1.96 freight to Pittsburgh. Demand is very light, although perhaps improving a trifle, and prices seem to be quite firmly held.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

		Carlots	Less Carlots
Acetic anhydride	lb.	..... –	$0.40 – $0.42
Acetone	lb.	$0.11½ – $0.12	.12½ – .12½
Acid, acetic, 28 per cent	100 lbs.	2.50 – 2.60	2.65 – 3.00
Acetic, 56 per cent	100 lbs.	5.00 – 5.25	5.30 – 5.50
Acetic, glacial, 99½ per cent, carboys, 100 lbs.		9.00 – 9.50	9.75 – 10.00
Boric, crystals	lb.	.11 – .11½	.11½ – .12
Boric, powder	lb.	.11½ – .11¾	.11½ – .12½
Citric	lb.	..... –	.46 – .46½
Hydrochloric	100 lb.	1.15 – 1.25	1.30 – 1.75
Hydrofluoric, 52 per cent	lb.	.11 – .11½	.11 – .12
Lactic, 44 per cent tech	lb.	.09½ – .10	.10½ – .12
Lactic, 22 per cent tech	lb.	.04 – .04½	.04½ – .05
Molybdic, c.p.	lb.	3.00 – 3.25	3.30 – 3.75
Muriatic, 20 deg. (see hydrochloric)		..... –	..... – .....
Nitric, 40 deg	lb.	.06½ – .06¾	.06½ – .07
Nitric, 42 deg	lb.	.06½ – .07	.07½ – .07¾
Oxalic, crystals	lb.	.11½ – .12	.12½ – .13
Phosphoric, 50 per cent solution	lb.	.08 – .08½	.08½ – .09½
Picric	lb.	.20 – .25	.27 – .35
Pyrogallic, resublimed	lb.	..... –	1.65 – 1.75
Sulphuric, 60 deg., tank cars	ton	10.00 – 11.00	..... – .....
Sulphuric, 60 deg., drums	ton	12.00 – 14.00	..... – .....
Sulphuric, 66 deg., tank cars	ton	16.00 – 16.50	..... – .....
Sulphuric, 66 deg., drums	ton	20.00 – 20.50	21.00 – 22.00
Sulphuric, 66 deg., carboys	ton	..... –	..... – .....
Sulphuric, fuming, 20 per cent (oleum) tank cars	ton	19.50 – 20.00	..... – .....
Sulphuric, fuming, 20 per cent (oleum) drums	ton	22.00 – 22.50	23.00 – 24.00
Sulphuric, fuming, 20 per cent (oleum) carboys	ton	31.00 – 32.00	33.00 – 34.00
Tannic, U. S. P	lb.	..... –	.60 – .75
Tannic (tech.)	lb.	.40 – .45	.46 – .50
Tartaric, imported crystals	lb.	..... –	.26½ – .28
Tartaric acid, imported, powdered	lb.	..... –	.27½ – .30
Tartaric acid, domestic	lb.	..... –	..... – .30
Tungstic, per lb. of WO	lb.	..... –	1.00 – 1.10
Alcohol, ethyl	gal.	..... –	4.75 – 5.50
Alcohol, methyl (see methanol)		..... –	..... – .....
Alcohol, denatured, 188 proof No. 1	gal.	..... –	.32 – .34
Alcohol, denatured, 188 proof No. 5	gal.	..... –	.32 – .34
Alum, ammonia, lump	lb.	.03½ – .03¾	.04 – .04½
Alum, potash, lump	lb.	.03½ – .04	.04½ – .05
Alum, chrome lump	lb.	.07½ – .08	.08½ – .08¾
Aluminum sulphate, commercial	100 lb.	1.65 – 1.85	1.90 – 2.40
Aluminum sulphate, iron free	lb.	.02½ – .02¾	.03 – .03½
Aqua ammonia, 26 deg., drums (750 lb.)	lb.	.07½ – .07¾	.08 – .08½
Ammonia, anhydrous, cyl. (100-150 lb.)	lb.	.30 – .30½	.31 – .33
Ammonium carbonate, powder	lb.	.07 – .07½	.08 – .09
Ammonium nitrate	lb.	.06½ – .07	.07½ – .07¾
Amylacetate tech	gal.	..... –	2.00 – 2.40
Arsenic, white, powdered	lb.	.07½ – .07¾	.07½ – .08
Arsenic, red, powdered	lb.	.12 – .12½	.12½ – .13
Barium chloride	ton	80.00 – 85.00	86.00 – 90.00
Barium dioxide (peroxide)	lb.	.20 – .21	.21½ – .22
Barium nitrate	lb.	.06½ – .07	.07½ – .08½
Barium sulphate (precip.) (blanc fixe)	lb.	.03½ – .04	.04½ – .04½
Blanc fixe, dry	lb.	.04 – .04½	..... – .....
Blanc fixe, pulp	ton	45.00 – 55.00	..... – .....
Bleaching powder	100 lb.	1.70 – 1.95	2.00 – 3.00
Blue vitriol (see copper sulphate)		..... –	..... – .....
Borax	lb.	.05½ – .05½	.06 – .06½
Brimstone (see sulphur, roll)		..... –	..... – .....
Bromine	lb.	.27 – .28	.28½ – .35
Calcium acetate	100 lbs.	1.75 – 2.00	..... – .....
Calcium carbide	lb.	.04½ – .04¾	.05 – .05½
Calcium chloride, fused, lump	ton	24.00 – 24.50	24.75 – 27.00
Calcium chloride, granulated	lb.	.01½ – .02	.02½ – .02½
Calcium peroxide	lb.	..... –	1.40 – 1.50
Calcium phosphate, tribasic	lb.	..... –	.15 – .16
Camphor	lb.	..... –	.89 – .91
Carbon bisulphide	lb.	.06 – .06½	.06½ – .07½
Carbon tetrachloride, drums	lb.	.09½ – .10	.10½ – .12
Carbonyl chloride, (phosgene)	lb.	..... –	.60 – .75
Caustic potash (see potassium hydroxide)		..... –	..... – .....
Caustic soda (see sodium hydroxide)		..... –	..... – .....
Chalk, precip.—domestic, light	lb.	.04½ – .04¾	..... – .....
Chalk, precip.—domestic, heavy	lb.	.05½ – .05¾	..... – .....
Chalk, precip.—imported, light	lb.	.04½ – .05	..... – .....
Chlorine, gas, liquid-cylinders (100 lb.)	lb.	.06 – .06½	.06½ – .07
Chloroform	lb.	..... –	.37 – .40
Cobalt oxide	lb.	..... –	2.00 – 2.10
Copperas	ton	15.00 – 16.00	16.50 – 30.00
Copper carbonate, green precipitate	lb.	.19 – .20	.20½ – .21
Copper cyanide	lb.	..... –	.58 – .60
Copper sulphate, crystals	100 lb.	5.55 – 5.65	5.70 – 6.25
Cream of tartar	lb.	..... –	.23½ – .25
Epsom salt (see magnesium sulphate)		..... –	..... – .....
Ethyl acetate com. 85%	gal.	..... –	.60 – .65
Ethyl acetate, pure (acetic ether, 98% to 100%)	gal.	..... –	.93 – 1.00
Formaldehyde, 40 per cent	lb.	.08½ – .09	.09½ – .10
Fullers earth, f.o.b. mines	net ton	16.00 – 17.00	..... – .....
Fullers earth–imported powdered–net	ton	30.00 – 32.00	..... – .....
Fusel oil, ref	gal.	..... –	2.50 – 3.00
Fusel oil, crude	gal.	..... –	1.40 – 1.75
Glauber's salt (see sodium sulphate)		..... –	..... – .....
Glycerine, c. p. drums extra	lb.	..... –	.16 – .17
Iodine, resublimed	lb.	..... –	4.05 – 4.15
Iron oxide, red	lb.	..... –	.12 – .18
Lead acetate	lb.	..... –	.09 – .11½
Lead arsenate, powd	lb.	.15 – .15½	.15½ – .16½
Lead nitrate	lb.	..... –	.15 – .20
Litharge	lb.	.07½ – .07½	.08 – .08½
Magnesium carbonate, technical	lb.	.06 – .06½	.06½ – .08
Magnesium sulphate, U. S. P	100 lb.	2.60 – 2.65	2.70 – 3.00
Magnesium sulphate, technical	100 lb.	..... –	1.00 – 1.80
Methanol, 95%	gal.	..... –	.57 – .58
Methanol, 97%	gal.	..... –	.59 – .60
Nickel salt, double	lb.	..... –	.11 – .11½
Nickel salt, single	lb.	..... –	.11 – .11½
Phosgene (see carbonyl chloride)		..... –	..... – .....
Phosphorus, red	lb.	.45 – .46	.47 – .50
Phosphorus, yellow	lb.	..... –	.30 – .35
Potassium bichromate	lb.	.10½ – .10½	.10½ – .10½
Potassium bromide, granular	lb.	..... –	.20 – .25
Potassium carbonate, U. S. P	lb.	.12 – .12½	.13 – .16
Potassium carbonate, 80–85%	lb.	.04½ – .04½	.05 – .06
Potassium chlorate, crystals	lb.	.05½ – .06	.06½ – .08
Potassium cyanide	lb.	..... –	.42 – .45
Potassium hydroxide (caustic potash)	100 lb.	6.25 – 6.40	6.45 – 7.00
Potassium iodide	lb.	..... –	3.10 – 3.15
Potassium nitrate	lb.	.07½ – .07½	.08 – .09
Potassium permanganate	lb.	.16 – .17	.17½ – .22
Potassium prussiate, red	lb.	nominal	nominal
Potassium prussiate, yellow	lb.	.26 – .26½	.26½ – .27
Rochelle salts (see sodium potas. tartrate)		..... –	..... – .....
Salammoniac, white, granular	lb.	.07½ – .07½	.07½ – .08
Salammoniac, gray, granular	lb.	.07½ – .07½	.07½ – .08
Salsoda	100 lb.	1.60 – 1.70	1.75 – 2.00
Salt cake (bulk)	ton	17.00 – 20.00	..... – .....
Soda ash, light	100 lb.	1.80 – 2.00	2.05 – 2.60
Soda ash, dense	100 lb.	1.85 – 1.95	2.00 – 2.50
Sodium acetate	lb.	.04½ – .04½	.04½ – .05
Sodium bicarbonate	100 lb.	1.80 – 1.90	1.95 – 2.40
Sodium bichromate	lb.	.07½ – .08	.08½ – .08½
Sodium bisulphate (nitre cake)	ton	4.50 – 4.60	4.65 – 5.50
Sodium bisulphite powdered, U.S.P	lb.	.04½ – .04½	.04½ – .05½
Sodium chlorate	lb.	.06½ – .07	.07½ – .07½
Sodium chloride	long ton	12.00 – 13.00	..... – .....
Sodium cyanide	lb.	.22½ – .26	.26½ – .27½
Sodium fluoride	lb.	.09½ – .10	.10½ – .10½
Sodium hydroxide (caustic soda)	100 lb.	3.70 – 3.75	3.80 – 4.30
Sodium hyposulphite	lb.	.03½ – .03½	.03½ – .04
Sodium nitrite	lb.	.08½ – .08½	.09 – .09½
Sodium peroxide, powdered	lb.	.28 – .30	.31 – .35
Sodium phosphate, dibasic	lb.	.03½ – .04	.04½ – .04½
Sodium potassium tartrate (Rochelle salts)	lb.	..... –	.18 – .21
Sodium prussiate, yellow	lb.	.17½ – .17½	.17½ – .18
Sodium silicate, solution (40 deg.)	100 lb.	.85 – 1.00	1.05 – 1.15
Sodium silicate, solution (60 deg.)	100 lb.	2.50 – 2.60	2.65 – 3.00
Sodium sulphate, crystals (glaubers salt)	100 lbs.	.95 – 1.10	1.15 – 1.50
Sodium sulphide, fused, 60-62 per cent (cone.)	lb.	.04½ – .04½	.04½ – .05½
Sodium sulphite, crystals	lb.	.03½ – .03½	.03½ – .04½
Strontium nitrate, powdered	lb.	.10 – .11	.11½ – .15
Sulphur chloride, yellow	lb.	.04½ – .05	.05½ – .06
Sulphur, crude	ton	18.00 – 20.00	..... – .....
Sulphur dioxide, liquid, cylinders extra	lb.	.08 – .08½	.09 – .10
Sulphur (sublimed), flour	100 lb.	..... –	2.25 – 3.10
Sulphur, roll (brimstone)	100 lb.	..... –	2.00 – 2.75
Talc—imported	ton	30.00 – 40.00	..... – .....
Talc—domestic powdered	ton	18.00 – 25.00	..... – .....
Tin bichloride	lb.	.09 – .09½	.09½ – .10
Tin oxide	lb.	..... –	.37 – .38
Zinc carbonate	lb.	.14 – .14½	.14½ – .15½
Zinc chloride, gran	lb.	.05½ – .06	.06½ – .06½
Zinc cyanide	lb.	.42 – .44	.45 – .47
Zinc oxide, XX	lb.	.07½ – .08	.08½ – .08½
Zinc sulphate	100 lb.	2.75 – 3.00	3.05 – 3.30

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude	lb.	$1.00 — $1.05
Alpha-naphthol, refined	lb.	1.10 — 1.15
Alpha-naphthylamine	lb.	.30 — .31
Aniline oil, drums extra	lb.	.16½ — .17
Aniline salts	lb.	.24 — .26
Anthracene, 80% in drums (100 lb.)	lb.	.75 — 1.00
Benzaldehyde U.S.P	lb.	1.25 — 1.30
Benzidine, base	lb.	.85 — .95
Benzidine sulphate	lb.	.75 — .85
Benzoic acid, U.S.P	lb.	.60 — .65
Benzoate of soda, U.S.P	lb.	.55 — .57
Benzene, pure, water-white, in drums (100 gal.)	gal.	.29 — .35
Benzene, 90%, in drums (100 gal.)	gal.	.27 — .32
Benzyl chloride, 95-97%, refined	lb.	.25 — .27
Benzyl chloride, tech	lb.	.20 — .23
Beta-naphthol benzoate	lb.	3.75 — 4.00
Beta-naphthol, sublimed	lb.	.60 — .65
Beta-naphthol, tech	lb.	.27 — .30
Beta-naphthyla mine, sublimed	lb.	1.50 — 1.60
Cresol, U. S. P., in drums (100 lb.)	lb.	.12 — .15
Ortho-cresol, in drums (100 lb.)	lb.	.16 — .18
Cresylic acid, 97–99%, straw color, in drums	gal.	.50 — .52
Cresylic acid, 95-97%, dark, in drums	gal.	.45 — .47
Dichlorbenzene	lb.	.06 — .09
Diethylaniline	lb.	1.15 — 1.20
Dimethylaniline	lb.	.38 — .40
Dinitrobenzene	lb.	.23 — .25
Dinitroclorbenzene	lb.	.23 — .25
Dinitronaphthalene	lb.	.30 — .32
Dinitrophenol	lb.	.33 — .35
Dinitrotoluene	lb.	.22 — .24
Dip oil, 25%, car lots, in drums	gal.	.24 — .26
Dipnenylamine	lb.	.59 — .70
H-acid	lb.	.85 — 1.06
Meta-phenylenediamine	lb.	.90 — 1.00
Monochlorbenzene	lb.	.14 — .15
Monoethylaniline	lb.	1.20 — 1.25
Naphthalene crushed, in bbls	lb.	.06 — .06½
Naphthalene, flake	lb.	.06½ — .07
Naphthalene, balls	lb.	.08 — .08½
Naphthionic acid, crude	lb.	.65 — .70
Nitrobenzene	lb.	.10 — .12
Nitro-naphthalene	lb.	.30 — .35
Nitro-toluene	lb.	.15 — .17½
Ortho-amidophenol	lb.	2.75 — 2.80
Ortho-dichlor-benzene	lb.	.15 — .20
Ortho-nitro-phenol	lb.	.75 — .80
Ortho-nitro-toluene	lb.	.12 — .15
Ortho-toluidine	lb.	.16 — .21
Para-amidophenol, base	lb.	1.25 — 1.30
Para-amidophenol, HCl	lb.	1.30 — 1.35
Para-dichlorbenzene	lb.	.15 — .18
Paranitroaniline	lb.	.75 — .77
Para-nitrotoluene	lb.	.70 — .75
Para-phenylenediamine	lb.	1.50 — 1.55
Para-toluidine	lb.	1.10 — 1.15
Phthalic anhydride	lb.	.35 — .38

Phenol, U. S. P., drums	lb.	.11½	—	15
Pyridine	gal.	1.75	—	2.75
Resorcinol, technical	lb.	1.30	—	1.35
Resorcinol, pure	lb.	1.75	—	1.80
Salicylic acid, tech., in bbls.	lb.	.20	—	.21
Salicylic acid, U. S. P.	lb.	.22	—	.23
Solvent naphtha, water-white, in drums, 100 gal.	gal.	.25	—	.28
Solvent naphtha, crude, heavy, in drums, 100 gal.	gal.	.10	—	.12
Sulphanilic acid, crude	lb.	.25	—	.27
Tolidine	lb.	1.20	—	1.30
Toluidine, mixed	lb.	.32	—	.38
Toluene, in tank cars	gal.	.25	—	.28
Toluene, in drums	gal.	.30	—	.35
Xylidines, drums, 100 gal	lb.	.40	—	.45
Xylene, pure, in drums	gal.	.40	—	.45
Xylene, pure, in tank cars	gal.	.45	—	....
Xylene, commercial, in drums, 100 gal.	gal.	.33	—	.35
Xylene, commercial, in tank cars	gal.	.30	—	....

Waxes

Prices based on original packages in large quantities.

Bayberry Wax	lb.	$0.20	—	$0.21
Beeswax, refined, dark	lb.	.25	—	.28
Beeswax, refined, light	lb.	.30	—	.32
Beeswax, white pure	lb.	.35	—	.40
Candellila, wax	lb.	.25	—	.26
Carnauba, No. 1	lb.	.45	—	.46
Carnauba No. 2, North Country	lb.	.24½	—	.25
Carnauba, No. 3, North Country	lb.	.15½	—	.16
Japan	lb.	.17½	—	.18
Montan, crude	lb.	.04½	—	.04½
Paraffine waxes, crude match wax (white) 105-110 m.p.	lb.	.04½	—	.04½
Paraffine waxes, crude, scale 124-126 m.p.	lb.	.02½	—	....
Paraffine waxes, refined, 118-120 m.p.	lb.	.03	—	.03¼
Paraffine waxes, refined, 125 m.p.	lb.	.03½	—	.03¾
Paraffine waxes, refined, 128-130 m.p.	lb.	.04	—	.04¼
Paraffine waxes, refined, 133-135 m.p.	lb.	.04½	—	.04¾
Paraffine waxes, refined, 135-137 m.p.	lb.	.05	—	.05¼
Stearic acid, single pressed	lb.	.08½	—	.09
Stearic acid, double pressed	lb.	.09½	—	.09½
Stearic acid, triple pressed	lb.	.10¼	—	.10½

Naval Stores

All prices are f.o.b. New York unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Rosin B-D, bbl.	280 lb.	$5.15	—	5.20
Rosin E-I	280 lb.	5.25	—	5.30
Rosin K-N	280 lb.	5.90	—	6.65
Rosin W. G.-W. W.	280 lb.	7.00	—	7.25
Wood rosin, bbl.	280 lb.	6.25	—	....
Spirits of turpentine	gal.	.87	—	....
Wood turpentine, steam dist.	gal.	.84	—	....
Wood turpentine, dest. dist.	gal.	.68	—	.70
Pine tar pitch, bbl.	200 lb.	.....	—	6.00
Tar, kiln burned, bbl. (500 lb.)	bbl.	.....	—	9.50
Retort tar, bbl.	500 lb.		—	9.00
Rosin oil, first run	gal.	.36	—	....
Rosin oil, second run	gal.	.38	—	....
Rosin oil, third run	gal.	.46	—	....
Pine oil, steam dist., sp.gr., 0.930-0.940	gal.			$1.90
Pine oil, pure, dest. dist.	gal.			1.50
Pine tar oil, ref., sp.gr. 1.025-1.035	gal.			.46
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla.	gal.			.35
Pine tar oil, double ref., sp.gr. 0.965-0.990	gal.			.75
Pine tar, ref., thin, sp.gr., 1.080-1.960	gal.			.35
Turpentine, crude, sp. gr., 0.900-0.970	gal.			1.25
Hardwood oil, f.o.b. Mich., sp.gr., 0.960-0.990	gal.			.35
Pinewood creosote, ref.	gal.			.52

Fertilizers

Sulphate of Ammonia—f.a.s. N. Y.,—100 lb.—$3.50
All other prices remain quotably unchanged

Crude Rubber

Prices remain same as previous report.

Oils

VEGETABLE

The following prices are f.o.b. New York for carload lots.

Castor oil, No. 3, in bbls.	lb.	$0.10	—	$0.10½
Castor oil, AA, in bbls.	lb.	.11½	—	.12
China wood oil, in bbls.	lb.	.14½	—	.14¾
Coconut oil, Ceylon grade, in bbls.	lb.	.09	—	.09½
Coconut oil, Cochin grade, in bbls.	lb.	.09½	—	.10
Corn oil, crude, in bbls.	lb.	.11¼	—	.11½
Cottonseed oil, crude (f. o. b. mill)	lb.	.10	—	.10½
Cottonseed oil, summer yellow	lb.	.11½	—	.12
Cottonseed oil, winter yellow	lb.	.13¼	—	.13½
Linseed oil, raw, car lots (domestic)	gal.	.79	—	.80
Linseed oil, raw, tank cars (domestic)	gal.	.75	—	.76
Linseed oil, in 5-bbl lots (domestic)	gal.	.82	—	.83
Olive oil, denatured	gal.	1.12	—	1.15
Palm, Lagos	lb.	.08	—	.08½
Palm, Niger	lb.	.06½	—	.06½
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	.10	—	.10½
Peanut oil, refined, in bbls.	lb.	.12½	—	.13
Rapeseed oil, refined in bbls.	gal.	.85	—	.86
Rapeseed oil, blown, in bbls.	gal.	.87	—	.88
Soya bean oil (Manchurian), in bbls. N. Y.	lb.	.11	—	....
Soya bean oil, tank cars, f.o.b., Pacific coast	lb.	.09½	—	....

FISH

Light pressed menhaden	gal.	$0.54	—	....
Yellow bleached menhaden	gal.	.57	—	....
White bleached menhaden	gal.	.56	—	....
Blown menhaden	gal.	.61	—	....

Miscellaneous Materials

All f.o.b. New York Unless Otherwise Stated

Shellac, orange fine	lb.	.87	—	.88
Shellac, orange superfine	lb.	.90	—	.91
Shellac, A. C. garnet	lb.	.72	—	.73
Shellac, T. N.	lb.	.85	—	.86

All other prices remain unchanged.

Refractories

Bauxite brick, 56% Al, f.o.b. Pittsburgh	per 1,000	$130.00
Carborundum refractory brick, 9-in.	1,000	1100.00
Chrome brick, f.o.b. Eastern shipping points	net ton	41–44
Chrome cement, 40-50% Cr_2O_3	net ton	30–32
Chrome cement, 40-45% Cr_2O_3, sacks, in car lots, f.o.b. Eastern shipping points	net ton	30–32
Fireclay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works	1,000	32–37
Fireclay brick, 2nd quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works	1,000	27–30
Magnesite brick, 9-in. straight (f.o.b. works)	net ton	53–55
Magnesite brick, 9-in. arches, wedges and keys	net ton	70
Magnesite brick, soaps and splits	net ton	90
Silica brick, 9-in. sizes, f.o.b. Chicago district	1,000	35–37
Silica brick, 9-in. sizes, f.o.b. Birmingham district	1,000	37–39
Silica brick, 9-in. sizes, f.o.b. Mt. Union, Pa.	1,000	27–30

Ferro-Alloys

Quotations remain same as previous report

Ores and Semi-finished Products

Prices same as March 22nd report

Non-Ferrous Metals

New York Markets

	Cents per Lb.
Copper, electrolytic	12.875
Aluminum, 98 to 99 per cent.	19.00
Antimony, wholesale lots, Chinese and Japanese	4.25
Nickel, ordinary (ingot)	41.00
Nickel, electrolytic	44.00
Nickel, electrolytic, resale	32.00
Monel metal, shot and blocks	35.00
Monel metal, ingots	38.00
Monel metal, sheet bars	40.00
Tin, 5-ton lots, Straits	29.25
Lead, New York, spot	4.70–4.75
Lead, E. St. Louis, spot	4.40–4.45
Zinc, spot, New York	5.15
Zinc, spot, E. St. Louis	4.675–4.70

OTHER METALS

Silver (commercial)	oz.	$0.65½
Cadmium	lb.	1.00–1.10
Bismuth (500 lb. lots)	lb.	2.00@2.10
Cobalt	lb.	3.00@3.25
Magnesium	lb.	1.15
Platinum	oz.	85.00@ 90.00
Iridium	oz.	170.00@190.00
Palladium	oz.	55.00@ 60.00
Mercury	75 lb.	50.00

FINISHED METAL PRODUCTS

	Warehouse Price Cents per Lb.
Copper sheets, hot rolled	19.25
Copper bottoms	27.75
Copper rods	19.25
High brass wire	16.75
High brass rods	14.25
Low brass wire	18.25
Low brass rods	18.75
Brazed brass tubing	23.00
Brazed bronze tubing	28.00
Seamless copper tubing	20.75
Seamless high brass tubing	18.00

OLD METALS—The following are the dealers' purchasing prices in cents per pound:

	New York Current
Copper, heavy and crucible	10.25@10.50
Copper, heavy and wire	10.00@10.25
Copper, light and bottoms	7.75@ 8.25
Lead, heavy	3.60@ 3.85
Lead, tea	3.00@ 3.25
Brass, heavy	4.50@ 4.75
Brass, light	4.00@ 4.25
No. 1 yellow brass turnings	4.00@ 4.25
Zinc	2.25@ 2.50

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Alabama

GADSDEN—The E. J. Owen Co., 6th St., has preliminary plans under way for the erection of a new foundry for the manufacture of iron and other metal castings.

Arkansas

FORT SMITH—The Fort Smith Glass Products Co., recently organized, is arranging for the establishment of a local plant for the manufacture of bottles and other glass products, with initial output of about 40,000 bottles per day. C. M. Penn is president, and L. E. Duckworth, secretary and treasurer.

California

NATIONAL CITY—The Jet Oil Co., has acquired a local site for the erection of a new plant for the production of lubricating oils. The first unit is estimated to cost about $55,000. Plans will be prepared at an early date.

TEHACHAPI—The Henry Cowell Lime & Cement Co., 2 Market St., San Francisco, has acquired a tract of property in the vicinity of Tehachapi, and plans for the erection of a new cement-manufacturing plant and lime works. The plant will consist of a number of buildings, and is estimated to cost in excess of $750,000.

Connecticut

STAMFORD—The Stamford Foundry Co., Canal St., has had plans prepared for the construction of an addition to its plant, with improvements in the present foundry. Emmens & Abbott, Stamford, are architects.

TORRINGTON—The Anaconda Copper Co., 25 Broadway, New York, N. Y., has tentative plans under consideration for the erection of an addition to the plant of the American Brass Co., a subsidiary, at Torrington, to be equipped as a rolling mill.

Georgia

LUDOWICI—The McDonald Brick Co., operated by C. J. McDonald & Sons, is planning for enlargements in the local plant of the Ludowici Brick & Tile Co., recently acquired. The capacity will be increased to about 60,000 bricks daily. A number of improvements will be made also in the existing works.

Illinois

MATTESON — The new chemical plant to be erected here will be owned and operated by the K. I. Herman Chemical Corp., 332 South Michigan Ave., Chicago, and not by the Mid-West Box Co., Chicago, as recently noted in these columns. K. I. Herman, president of the chemical company, has been secretary and general manager of the Mid-West company, recently organizing the company bearing his name with a capital of $300,000, under Illinois laws. The plant will be 3-story, 60 x 140 ft. Harvey C. Miller, 112 West Adams St., Chicago, is architect.

CHICAGO—Fire, March 9, destroyed the north section of the plant of the Elaborated Ready Roofing Co., 44th and La Salle Sts., manufacturer of asphalt roofing products, comprising a 2-story factory with machinery. The loss is estimated at about $42,000.

Kansas

WICHITA—The Golden Rule Refining Co. is planning for the rebuilding of the section of its local oil refinery, destroyed by fire, March 6, at 29th St. and Topeka Ave.

CRESTLINE—The Kanok Metal Co. is considering tentative plans for the rebuilding of its concentrating plant, recently destroyed by fire with loss estimated at $45,000, including equipment.

Kentucky

NEWPORT—Officials of the Kentucky Rolling Mills Co. have organized the Andrews Steel Co., under Delaware laws, with capital of $750,000, and are reported to be planning for the erection of a new blast furnace and steel plant in the vicinity of Bay City, Mich., where options on property have been secured. The company is headed by Joseph B. and W. N. Andrews, Newport.

LOUISVILLE.—Ayer & Lord Tie Co., 80 East Jackson Blvd., Chicago, will build a 2-cylinder creosote plant here. The Leonard Construction Co. of Chicago will be in charge of material buying, which will consist mainly of steel tanks, creosote cylinders 130 ft. long by 7 ft. 6 in. diameter fabricated for 250-lb. pressure, tram cars, boilers, hydraulic pumps, air compressors.

Maryland

BALTIMORE—The American Sugar Refining Co. has filed plans for the erection of another building at its new sugar mill at Clement and Woodall Sts., to be 1-story, 62 x 73 ft.

BALTIMORE—The Colloidal Process Paint Co., Lexington Bldg., will expend about $30,000 for the erection of its new local plant, and will install equipment for a daily output of about 250 tons of bitumens. H. A. Hughes is secretary and treasurer.

BALTIMORE—The Mexican Petroleum Corp., 120 Broadway, New York, N. Y., will construct a new tankage and distributing plant on 1st St., to cost about $40,000. Work will be placed under way at once.

Missouri

CARUTHERSVILLE—The City Council will install a new water-purification plant in connection with extensions and improvements in the municipal waterworks. Black & Veatch, 701 Mutual Bldg., Kansas City, Mo., are engineers.

WEBB CITY—Fire, March 13, destroyed a portion of the refinery of the Wilhoit Oil Co. The estimated loss has not been announced; the loss in the tankage department approximated $30,000.

North Carolina

WILLETS — The Natural Abrasive Mining Co., Waynesville, N. C., is planning for the construction of a new grinding plant at its properties at Willets, with initial capacity of about 150 tons daily, estimated to cost about $100,000. An additional sum of approximately $200,000 will be used for development and general operatings, including new equipment. Frank R. Hewitt is treasurer.

New Jersey

TRENTON—The Semple Rubber Co. has acquired its leased plant on Murray St. for a consideration of about $40,000, consisting of a number of buildings, with adjoining site for expansion. The company manufactures inner tubes for automobile tires and other rubber products.

TRENTON—The Trent Brick Co., Princeton Ave., is considering plans for the rebuilding of the portion of its plant, recently destroyed by fire. A. W. Goulding is treasurer.

HOBOKEN—The Fisher-Sweeny Bronze Co., 1361 Grand St., is planning for the rebuilding of the portion of its plant, destroyed by fire, March 15, with loss estimated at close to $150,000, including equipment. The company specializes in the manufacture of bronze, brass and other metal castings.

EAST ORANGE—Plans have been prepared for the immediate installation of an automatic gas producer plant at the factory of the Ward Baking Co., Ampere section, 35 x 57 ft.

New York

GLENDALE, L. I.—The Conley Tin Foil Co., 521 West 25th St., New York, will soon break ground for the erection of a 1-story plant on Woodhaven Ave., Glendale, to cost about $175,000, including equipment. The general building contract has been let to the Foundation Co., 120 Liberty St., New York.

LOCKPORT—The A. W. Jack Corp., Mill St. and North Transit Road, manufacturer of asbestos millboard products, etc., is planning for the rebuilding of the portion of its plant, destroyed by fire, March 7.

Oklahoma

OKLAHOMA CITY— George Sohlberg and A. E. Kull, Oklahoma City, are organizing a new company, capitalized at $200,000, to establish a local plant for the manufacture of special metal castings.

MUSKOGEE—The Muskogee Vitrified Brick Co. is planning for the rebuilding of the portion of its plant recently destroyed by fire. F. C. Nicholson is president.

Pennsylvania

LANCASTER—The Armstrong Cork Co., Liberty and Mary Sts., will soon break ground for the erection of a 4- and 6-story addition to its plant, 50 x 215 ft. The general building contract has been let to Herman Wohlsen, Woolworth Bldg., Lancaster.

CHESTER—The Scott Paper Co., foot of Market St., has enlargements under way at its plant to increase the capacity about one-third. A number of improvements will be made in the present factory, including the installation of considerable new machinery. The work is estimated to cost about $450,000.

PHILADELPHIA—The Gulf Refining Co., Widener Bldg., has acquired property aggregating about 70 acres of land in the Girard Point district, as a site for the erection of a large distributing plant. Actual operations will be deferred until a later date. Wesley A. Looney is general manager.

Tennessee

NASHVILLE—In connection with its new plant at Old Hickory, the Nashville Pulp & Paper Corp. plans for the erection of a finished paper mill at a later date, with installation to comprise two 30-ton machines and auxiliary equipment. Three buildings are now in course of erection, with remodeling of a number of structures formerly used by the government. Equipment is being installed in the different plant departments and it is expected to commence production in a portion of the plant in May. R. J. Cullen is president and general manager.

Texas

DALLAS—The Davis Mfg. Co., Knoxville, Tenn., has construction under way on its new local plant for the manufacture of chemicals and chemical byproducts. It will be 3-story, totaling about 15,000 sq.ft. of space. The building will be owned by Dallas interests, and occupied under a long lease. It is planned to commence the installation of machinery at an early date. Grover C. Davis is president and general manager.

MARSHALL—The Darco Corp., Wilmington, Del., a subsidiary of the Atlas Powder Co., will proceed with the erection of three units of its new local plant, instead of limiting the work to a single unit, as originally planned. The construction is expected to require about 12 months. The plant will produce refined carbon for sugar, chemicals and other service, and when in full operation will give employment to about 1,000 operatives.

Virginia

RICHMOND—The Cauthorne Paper Co., Cary and Tenth Sts., has plans nearing completion for the erection of a new 4-story plant, and will commence erection at an early date. It will cost about $75,000. Carneal & Johnson, Richmond, are architects. R. A. Cauthorne is president.

West Virginia

ATHENS—The Town Council, in cooperation with the state, is arranging for the installation of a filtration plant in connection with the waterworks system, to be used, also, by the State Normal School. C. E. Collins, Drexel Bldg., Philadelphia, Pa., is engineer.

CHARLESTON—The Young Bros. Foundry Co., recently organized, is planning for the erection of a new 1-story plant for the manufacture of steel and other metal castings. R. M. and Walter Young head the company.

Washington

SPOKANE—The Bentley Paste Co., Minneapolis, Minn., is planning for the erection of a new branch plant at Spokane, for the manufacture of pastes and kindred products. V. E. Benley is vice-president.

New Companies

THE SPRINGFIELD MICA PRODUCTS CO., Boston, Mass., has been incorporated with a capital of $200,000, to manufacture mica products and affiliated specialties. William P. Heck is president; and F. L. Glover, 104 Coolidge Hill Road, Watertown, Mass., treasurer.

THE FEDERAL FIBRE CORP., New York, N. Y., has been incorporated with a capital of $50,000, to manufacture fiber products. The incorporators are R. C. Richter and E. T. Walton. The company is represented by J. G. Pekberton, 130 West 42d St., New York.

THE STANDARD BRICK CO., Macon, Ga., has been organized to manufacture brick and other burned clay products. The company will take over and consolidate the Bibb Brick Co., A. T. Small Brick Co. and the Cherokee Brick Co., all operating in this district. W. E. Dunwody is president.

THE DYSCO CHEMICAL CO., West Hoboken, N. J., has been incorporated with a capital of $50,000, to manufacture chemicals and chemical byproducts. The incorporators are Charles Rose and Carnig Ajamian. The company is represented by Charles Ajamian, 515 Bergenline Ave., West Hoboken.

THE HIGBIE SALT CO., 111 West Washington St., Chicago, Ill., has been incorporated with a capital of $50,000 to operate salt properties and manufacture salt byproducts. The incorporators are Fred K. Higbie, M. J. Haggerty and W. B. Nay.

THE PITT PAINT CO., Beaver, Pa., has been incorporated with a capital of $5,000, to manufacture paints, varnishes, etc. C. D. Miller, Wilkinsburg, Pa., is treasurer.

THE FRENCH-AMERICAN ENAMEL MFG. CO., Wilmington, Del., has been incorporated under state laws with capital of $100,000, to manufacture paints, enamels and kindred products. The company is represented by the Colonial Charter Co., Ford Bldg., Wilmington.

THE MODEL BRICK CO., Houston, Tex., has been incorporated with a capital of $10,000, to manufacture brick and other burned clay products. The incorporators are W. J. Carter and J. F. Meyer, both of Houston.

THE INTERNATIONAL RUBBER CO. OF AMERICA, Wilmington, Del., has been incorporated under state laws with a capital of $20,000,000, to manufacture tires and other rubber products. The company is represented by the Corporation Service Co., Wilmington.

THE PLATINUM METALS RESEARCH SYNDICATE, Grants Pass, Ore., has been incorporated with a capital of $50,000, to manufacture refined metals and engage in metallurgical experiments. The incorporators are Morton Webster and Henry M. Lancaster, both of Grants Pass.

THE NON-CORROSIVE PAINT CO., New York, N. Y., has been incorporated with a capital of $100,000, to manufacture metallic and other paints. The incorporators are A. Berman, J. P. Segal and R. Arenwald. The company is represented by I. Gainsburg, 258 Broadway, New York.

THE NORMA LABORATORIES, INC., Albany, N. Y., has been incorporated with a capital of $10,000, to manufacture chemicals and affiliated products. The incorporators are L. C and R. P. Branche. The company is represented by C. R. Watson, Albany.

THE CRESCENT RUBBER CO., Trenton, N. J., has been incorporated with a capital of $25,000, to manufacture rubber products. The incorporators are Martin M. Glassman, A. Abrahams and John L. Heher, 150 East State Street, Trenton.

THE CARBO BRICK CO., Berlin, Conn., has been incorporated with a capital of $100,000, to manufacture vitrified brick, terra cotta tile, etc. The incorporators are John Carbo, Edward J. Lardner and M. M. Lardner, all of Kensington, Conn.

THE BUTLER SILICA CO., Butler, Pa., has been incorporated with a capital of $15,000, to manufacture silica products. George B. Lambert, Butler, is treasurer.

THE SNEEZO CO., INC., 40 North Dearborn St., Chicago, Ill., has been incorporated with a capital of $25,000, to manufacture chemicals and chemical byproducts. The incorporators are J. Lewis, J. C. Turner and M. C. Suhr.

THE APOLLO FOUNDRY, INC., Brooklyn, N. Y., has been incorporated with a capital of $25,000, to manufacture iron, steel and other metal castings. The incorporators are represented by I. W. Eckstein, 61 Park Row, New York.

THE REX CHEMICAL CO., Washington, D. C., has been incorporated under Delaware laws with capital of $1,000,000, to manufacture chemicals and chemical byproducts. The incorporators are G. Victor Yonce and R. B. Sheldon, Salem, Va.; and Eugene A. Chanaberry, Washington. The company is represented by the Colonial Charter Co., Ford Bldg., Wilmington, Del.

THE NACCO CHEMICAL CO., 191 Market St., Newark, N. J., has filed notice of organization to manufacture chemical products. James A. Dennis, 34 South Tenth St., heads the company.

THE ROME FIREPROOFING CO., Rome, Ga., has been incorporated with a capital of $100,000, to manufacture brick and other burned clay products. The company will succeed to the plant and business of the Rome Brick & Tile Co. The incorporators are H. H. Woodruff, Rome; and B. Mifflin Hood, Atlanta, Ga. The last noted is head of the B. Mifflin Hood Brick Co.

E. E. ZIMMERMAN, INC., Pittsburgh, Pa., has been incorporated with a capital of $35,000, to manufacture paints, varnishes, etc. I. M. Anderson, 3874 Perrysville Ave., Pittsburgh, is treasurer.

THE NEW YORK LABORATORIES, INC., New York, N. Y., has been incorporated under Delaware laws, with capital of $250,000, to manufacture chemicals and affiliated products. The company is represented by the Delaware Registration Co., 900 Market St., Wilmington, Del.

THE IROQUOIS OIL CORP., 118 North La Salle St., Chicago, Ill., has been incorporated with a capital of $10,000, to manufacture petroleum products. The incorporators are John H. and Robert C. Quirk, and O. S. Springer.

THE SUPREME LEATHER CO., 131 New Jersey Railroad Ave., Newark, N. J., has filed notice of organization to manufacture leather products. James A. Veneziano, 201 Parker St., heads the company.

THE MOHAWK BRICK CO., Mechanicville, N. Y., has been incorporated with a capital of $20,000, to manufacture brick and other burned clay products. The incorporators are J. Vett and C. D. Agonisto. The company is represented by F. A. Tate, Mechanicville.

THE PIONEERS CONSOLIDATED PETROLEUM CO., Wilmington, Del., has been incorporated with a capital of $250,000, to manufacture petroleum products. The company is represented by the Corporation Trust Co. of America, du Pont Bldg., Wilmington.

THE FRENCH POLISH MFG. CO., 4716 Dorchester Ave., Chicago, Ill., has been organized to manufacture polishes and other chemical specialties. The company is headed by Fred W. Bentley and Jean B. Hassewar.

THE COLORLAKE CHEMICAL CO., New York, N. Y., has been incorporated with a capital of $10,000, to manufacture colors, chemicals, paint products, etc. The incorporators are R. E. Mertens, W. D. Goss, Jr., and H. G. Sidebotto. The company is represented by H. B. Corey, 290 Broadway, New York.

THE HUBBELL RUBBER CO., Wilmington, Del., has been incorporated under state laws with a capital of $600,000, to manufacture tires and other rubber products. The company is represented by the Corporation Registry Co., 900 Market St., Wilmington.

THE ZENITH PAINT & COLOR CORP., New York N. Y., has been incorporated with a capital of $125,000, to manufacture paints, varnishes, etc. The incorporators are G. and G. W. Miller, and S. Glasner. The company is represented by S. C. Sugarman, 1540 Broadway, New York.

THE ATLAS BULB CO., 289 Valley Road, West Orange, N. J., has filed notice of organization to manufacture glass bulbs and other glass products. The company is headed by M. D. Grove and Joseph A. Dorrity.

THE LOOP STEEL MFG. CO., Ponca City, Okla., has been incorporated with a capital of $500,000, to manufacture steel products. The incorporators are J. B. Hinkle, Ponca City; Swan C. Burnette, Pawhuska, Okla.; and C. H. Loop, Arkansas City, Kan.

THE BRITITE CHEMICAL CO., New York, N. Y., has been incorporated with a capital of $6,000, to manufacture chemical products for rust prevention and other service. The incorporators are L. M. Flohr, A. Rich and S. Schoening. The company is represented by J. H. Marsh, 220 Broadway, New York.

THE WALLACE OIL & REFINING CO., Wilmington, Del., has been incorporated under state laws, with capital of $500,000, to manufacture refined oil products. The company is represented by the Colonial Charter Co., Ford Bldg., Wilmington.

THE UTICA PAINT REMOVER CORP., Utica, N. Y., has been incorporated with a capital of $50,000, to manufacture chemical products. The incorporators are G. A. Armstrong and F. J. Matteson. The company is represented by W. S. Matteson, 400 Broadway, Utica.

THE NATIONAL LEAD-CONSTRUCTION CO., Jenkintown, Pa., has recently been formed. C. H. Kimberly is president. At present the company is interested in designing and installing all classes of lead work and will later enter the equipment field.

THE GREAT EASTERN GASOLINE REFINING CO., New York, N. Y., has been incorporated under Delaware laws, with capital of $500,000, to operate an oil and gasoline refining plant. The incorporators are Thomas P. Hall, Charles Sears and John G. Powers. The company is represented by the Colonial Charter Co., Ford Bldg., Wilmington.

Capital Increases, Etc.

THE CHICAGO HEIGHTS OIL MFG. CO., 140 West Van Buren St., Chicago, Ill., has filed notice of increase in capital from $45,000 to $100,000.

THE HUMPHREYS-MEXIA CO., Mexia, Tex., operating oil refineries, has filed notice of change of name to the Humphreys Oil Co., at the same time increasing its capital from $10,000,000 to $15,000,000.

THE NEW YORK COAL-TAR PRODUCTS & CHEMICAL CO., recently incorporated under Delaware laws with capital of $1,000,000, has filed notice of charter at Albany, N. Y., to operate in New York. The company is represented by I. D. Shneller, 25 West 43rd St., New York.

THE SINCLAIR CONSOLIDATED OIL CORP., 45 Nassau St., New York, N. Y., operating oil refineries, is disposing of a bond issue of $45,000,000, the proceeds to be used for general financing and operations.

THE DEFAY RUBBER WORKS, 45 North Third St., Easton, Pa., has filed a voluntary petition in bankruptcy.

THE STANDARD OIL CO. OF KENTUCKY, Louisville, is arranging for an increase in capital from $6,000,000 to $12,000,000.

Stockholders of the RYDON TIRE & RUBBER CO., 765 Broad St., Newark, N. J., are arranging for a dissolution of the corporation. Edgar J. Haaren is secretary.

THE CELLULOSE PRODUCTS, INC., 1459 Broadway, New York, N. Y., has arranged financing plans for increased operating capital, to be used for general expansion in production.

THE PHOENIX RUBBER MFG. CO., Boston, Mass., has filed an involuntary petition in bankruptcy.

THE AIR REDUCTION CO., 342 Madison Ave., New York, manufacturer of welding apparatus, has acquired the plant and business of the Davis-Bournonville Co., Van Wagnen Ave., Jersey City, N. J., manufacturer of oxy-acetylene equipment, and will operate the property as a subsidiary.

Industrial Notes

THE BONE CHAR PRODUCTS CO., LTD., of Allentown, Pa., recently sold its bone oil recovery plant to L. Martin Co. of New York, by the receiver, D. S. Chamberlin. The consideration was $20,000. A process for the recovery of bone oil by the use of a volatile solvent, chiefly benzene, was tried out at this plant, but was not commercially successful. It is understood that the New York company will use the plant as a storage warehouse.

HAROLD G. MANNING, chemical engineer and patent lawyer, who opened an office last April in Waterbury, Conn., has now changed his location to the new Waterbury National Bank Bldg., 193 Grand St., that city.

E. F. DREW & CO. has been incorporated at Albany, N. Y. The assets of E. F. Drew & Co., which have been in custody of the courts for the past few months, have been turned over to the new organization and the business of the company, its subsidiaries and its branches will be conducted as formerly.

THE SURFACE COMBUSTION CO., New York, has obtained the exclusive license for exploiting in this country and in foreign countries the Andrews rustproofing process which was used during the war by the British Government.

THE ALTAU CO., Balboa Bldg., San Francisco, Cal., is engaged in the development of deposits of fullers earth, diatomaceous earth and talc in California and Nevada.

W. S. ROCKWELL CO., New York, announces that Gibbons Bros., Ltd., Dudley, Worc., England, has been appointed its representative for the British Isles.

THE NATIONAL PACKAGING MACHINERY CO., Jamaica Plain, Mass., announces the appointment of John C. Kay as New York City representative, with offices at 90 West Broadway.

THE PETROLEUM IRON WORKS CO. announces the appointment of J. A. Connelly.

formerly manager of the Tampico, Mexico, office, as sales manager, with headquarters at Sharon, Pa.

HERVEY J. SKINNER of Skinner, Sherman & Esselen, Inc., chemist and engineer, of Boston, has been selected as technical adviser by the Associated Industries of Massachusetts. The executive committee of that organization recently decided to establish a technical information service similar to its legal, taxation, accounting, insurance and banking services. The new technical information service, to be conducted by Mr. Skinner, will answer inquiries on industrial processes used in manufacturing operations. It will be in a position to advise members on technical subjects and to give general information that will be of material assistance in solving industrial problems. Care will be exercised to discriminate between information which should be furnished free and that for which members of the Associated Industries of Massachusetts should retain a competent firm of engineers.

THE HARDER FURNACE & ENGINEERING CORP. announces the sale of its licenses to use the Harder patents and of the services of its engineering department of the Fuels Utilization Corp., Knickerbocker Bldg., 152 West 42nd St., New York City. The Harder Furnace & Engineering Corp. will move to that address and occupy adjacent offices.

THE ORTON & STEINBRENNER CO., Chicago, Ill., manufacturer of locomotive cranes, clam-shell and orange-peel buckets and coal crushers, has made arrangements with Walter Hasendahl, 1213 Fuller Ave., Los Angeles, Cal., to act as representative in southern California.

LLOYD A. HALL has severed his connection as manager of Vodin, Inc., to establish business on his own account under the name of the Chicago Chemical Products Co., 6148 Wentworth Ave., Chicago. This company is engaged in a general line of manufacture, including toilet specialties, insecticides and automobile polishes.

THE WILSON WELDER & METALS CO., New York, announces the appointment of R. L. White as district manager in charge of the Detroit office.

THE GEORGE J. HAGAN CO., Pittsburgh, Pa., has opened two new offices. One is at 20 East Jackson Boulevard, Chicago, in charge of V. A. Hain, and the other in the Murphy Bldg., Detroit, in charge of J. Sandberg.

J. T. DONALD & CO., LTD., chemical engineer and consulting chemist, of Montreal, announces its removal to new and larger premises at 40-42 Belmont St., which the company has purchased and specially equipped for its laboratory and consulting work.

THE PNEUMERCATOR CO., INC., manufacturer of pneumatic mercury gages for measuring liquid contents of tanks, has moved its factory from Philadelphia, Pa., to the Sperry Bldg., 40 Flatbush Ave. Extension, Brooklyn, N. Y. Its general offices will be transferred from 15 Park Row, New York City, to the new factory location.

THE ARMSTRONG CORK CO., Pittsburgh, Pa., has opened a new office in Milwaukee, Wis., at 1011 Majestic Bldg. Hugh Krampe is in charge. It is also announced that the Denver office has been reinstated and is in charge of Alexander Callow.

THE DAYTON-DOWD CO., Quincy, Ill., announces the opening of a district office in Pittsburgh at 809 Keenan Bldg., covering the sale of centrifugal pumps and Underwriters' fire pumps. The office will be in charge of T. J. Barry, who for the past several years has been connected with the home office on engineering and sales.

WALLACE & TIERNAN CO., INC., Newark, N. J., announces the opening of an office in the McKnight Bldg., Minneapolis, Minn., which is in charge of B. M. Conaty, formerly of its Chicago office. This new district will cover the states of Minnesota, North Dakota, South Dakota and Montana, and the Canadian provinces of Alberta, Saskatchewan and Manitoba. It is also announced that E. M. Lawson, formerly of its San Francisco office, has become its representative at Kansas City, located at 707 Commerce Bldg.; that R. B. Mowry has recently been appointed its representative for the New Jersey, Delaware and Maryland districts, and will be located at the Newark, N. J., office; that Wallace & Tiernan, Ltd., was recently organized with headquarters at 73 Adelaide St., East, Toronto, Ont., Canada, in charge of J. Van Benschoten; that several additions have been made to its technical force recently, including S. H. Gregg and G. I. Nelson, who will become attached to the personnel of its Chicago office; A. LoPrest, who will become attached to the San Francisco office; R. M. Finch, who will be attached to the main office at Newark, N. J., and also that in the main office sanitary and industrial sales will be handled separately—L. H. Goebel becoming manager of industrial sales and R. V. Donnelly becoming manager of sanitary sales.

THE MEDART PATENT PULLEY CO., St. Louis, Mo., announces the change of its corporate name to "The Medart Company."

THE READ MACHINERY CO., York, Pa., recently held its ninth annual convention of the executives and sales representatives. The keynote of the convention was the same as in former years, "Better Service to the Chemical Industries."

F. W. REISMAN and L. E. TURK, formerly traveling sales manager and treasurer, respectively, of the Quigley Furnace Specialties Co., New York, have organized and incorporated the Keystone Refractories Co. and will manufacture high-temperature cement and granular refractories. The office is located at 122 Liberty St., N. Y., and the factory is in Jersey City.

THE MCCLAVE-BROOKS CO., Scranton, Pa., has appointed A. R. St. John as manager of the New York office, succeeding S. G. Smith, whose resignation took effect last January. Mr. St. John was formerly in charge of the Boston office. It is also announced that K. S. Holmes, Jr., has been appointed a representative of this company in Cincinnati, with offices in the Gwynne Bldg., and that the office at Charlotte, N. C., has been moved to Greenville, S. C.

THE HAUCK MFG. CO., Brooklyn, N. Y., has removed its Philadelphia office to 1726 Sansom St. Herbert Vogelsang, who has been connected with the company for 6 years, will be in charge.

THE COLORADO SOCIETY OF ENGINEERS at its recent annual meeting and banquet elected the following officers: President, R. M. Hosea; vice-president, W. M. McMechen; secretary-treasurer, C. M. Lightburn; directors, F. C. Dreher, I. C. Crawford, J. S. DeRemer, R. G. Hosea, F. C. Steinhauer, R. J. Randall, V. A. Kauffman, C. B. Daniels.

THE PACIFIC CHEMICAL CO. is now located in its new quarters at 70 Cliff St., New York.

THE RATHBUN JONES ENGINEERING CO., Toledo, O., has appointed the Ingersoll-Rand Co., New York, general sales agent for Rathbun gas engines.

DR. BAXERES DE ALZUGARAY, consulting chemist and metallurgist, announces the removal of his office and laboratory to 23 Washington St., New York.

THE PITTSBURGH TESTING LABORATORY, Pittsburgh, Pa., announced at its recent annual meeting the retirement of its president, George H. Clapp, his reappointment as a member of the board of directors of the company, and the election of Colonel James Milliken to the presidency of the company. Colonel Milliken's experience as a mechanical officer of the Pennsylvania Railroad Company, his experience in designing, constructing and in the shipment of all manner of the railroad equipment for the military railways shipped to France during the war and his subsequent experience fit him for the operation of this company.

THE SHALE OIL & REFINING CORP. has changed its name to "Industrial By-Products, Inc." but is still located at 25 Broadway, New York City.

THE SARGENT PAINT CO., of Indianapolis, Ind., has changed its firm name to "The Sargent-Gerke Co."

THE CHICAGO FLEXIBLE SHAFT CO. has resumed its St. Louis office, which is located in the Railway Exchange Bldg. It is in charge of J. J. Wittenburg, who has been with the Chicago office of the company for 3 years.

THE NORWALK IRON WORKS CO., South Norwalk, Conn., announces a number of changes in the executive personnel of the organization. The executive staff is now as follows: C. L. Thompson, president and general manager; Howard E. Adt, first vice-president; Harold B. Knowles, treasurer and assistant secretary; Thomas M. Steele, secretary; A. R. Betts, vice-president in charge of sales; W. E. Mathews, vice-president in charge of manufacturing and engineering; G. W. Wardwell, chief engineer; W. M. Greene, general superintendent.

The "Informashow" is the name of the exposition to be held at Exposition Park, Rochester, N. Y., May 15 to 20, under the direction of the Purchasing Agents Association of Rochester, N. Y., which is affiliated with the National Association of the Purchasing Agents.

THE C. W. HUNT CO., INC., of West New Brighton, Staten Island, N. Y., announces the reestablishment of its New York City office at 143 Liberty St. It has taken over all the sales and engineering work which has heretofore been carried on by its subsidiary company, the C. W. Hunt Engineering Corp., for the past 18 months, as the business of this latter corporation has now been consolidated with the C. W. Hunt Co., Inc.

THE BLAW-KNOX CO. has moved its New York office from the City Investing Bldg. to the Carbide & Carbon Bldg., 30 East 42nd St.

THE WORTHINGTON PUMP & MACHINERY CORP., New York, calls attention to Bulletin W-605, which is an instruction book for centrifugal pumps. There are informative data on the erection and installation of centrifugal pumps, a curve showing the maximum water temperature permissible for different suction lifts and curves showing the head capacity and efficiency capacity characteristics of the centrifugal pump. The bulletin is well illustrated. Copies will be sent upon request.

THE VULCAN SOOT CLEANER CO., DuBois, Pa., has recently issued Bulletin 548, on the use of Vulcan cleaners with Stirling boilers and Bull. 451, on B & W type boilers.

Coming Meetings and Events

AMERICAN CHEMICAL SOCIETY will hold its spring meeting at Birmingham, Ala., April 4 to 7, 1922.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its spring meeting in Baltimore, April 27, 28 and 29, 1922. Headquarters will be at the Emerson Hotel.

AMERICAN FOUNDRYMEN'S ASSOCIATION will hold its next convention and exhibit at Rochester, N. Y., during the week of June 5, 1922. Meetings will be held in the spring instead of in the fall as heretofore

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS will hold its summer meeting at Niagara Falls, June 19 to 22. Headquarters will be at the Clifton Hotel.

AMERICAN LEATHER CHEMISTS ASSOCIATION will hold its nineteenth annual meeting at Bigwin Inn, Bigwin Island, in the Lake of Bays district, Ontario, Canada, on June 21, 22 and 23.

AMERICAN OIL CHEMISTS' SOCIETY will hold its annual meeting at the Grunewald Hotel, New Orleans, La., May 8 and 9.

AMERICAN SOCIETY FOR STEEL TREATING will hold a sectional meeting at the Bureau of Mines auditorium, Pittsburgh, Pa., on May 25 and 26. The International Steel Exposition and Convention of the society will be held in the General Motors Bldg., Detroit, Mich., Oct. 2 to 7.

AMERICAN SOCIETY FOR TESTING MATERIALS will hold its twenty-fifth annual meeting June 26 to July 1, at Atlantic City, N. J. Headquarters will be at the Chalfonte-Haddon Hall Hotel.

INTERNATIONAL UNION OF PURE AND APPLIED CHEMISTRY will hold a meeting at Lyons, France, June 27 to 30.

IRON AND STEEL INSTITUTE (British) will hold its annual meeting on May 4 and 5 at the House of the Institution of Civil Engineers, Great George St., S. W., 1, London.

NATIONAL ASSOCIATION OF PURCHASING AGENTS EXPOSITION (the "Informashow") will be held in connection with the seventh annual convention of the association at Exposition Park, Rochester, N. Y., May 15 to 22.

NEW JERSEY CHEMICAL SOCIETY holds a meeting at Stetters Restaurant, 842 Broad St., Newark, N. J., the second Monday of every month.

STAMFORD CHEMICAL SOCIETY, Stamford, Conn., holds a meeting in the lecture room of the local high school on the fourth Monday of each month, except June, July, August and September.

TECHNICAL ASSOCIATION OF THE PULP AND PAPER INDUSTRY and the AMERICAN PULP AND PAPER ASSOCIATION will hold annual meetings at the Waldorf-Astoria, New York, the week of April 10.

The following meetings are scheduled to be held in Rumford Hall, the Chemists Club, New York: April 21—Society of Chemical Industry (in charge), American Electrochemical Society, Société de Chimie Industrielle, American Chemical Society, joint meeting; May 5—American Chemical Society, regular meeting; May 12—Société de Chimie Industrielle (in charge), American Chemical Society, Society of Chemical Industry, American Electrochemical Society, joint meeting; May 19—Society of Chemical Industry, regular meeting; June 9—American Chemical Society, regular meeting.